Aviation Week & Space Technology

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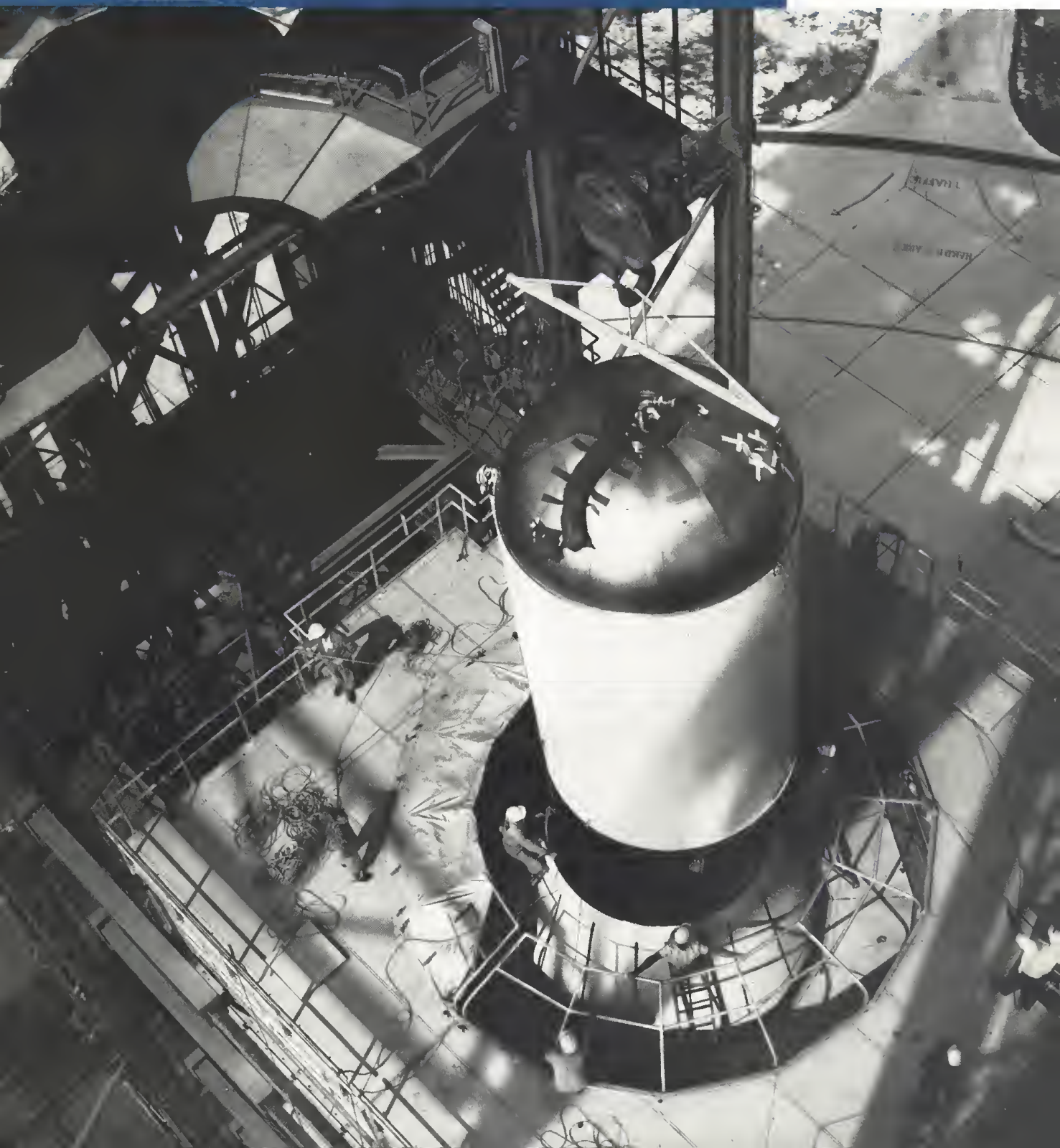
A McGraw-Hill Publication

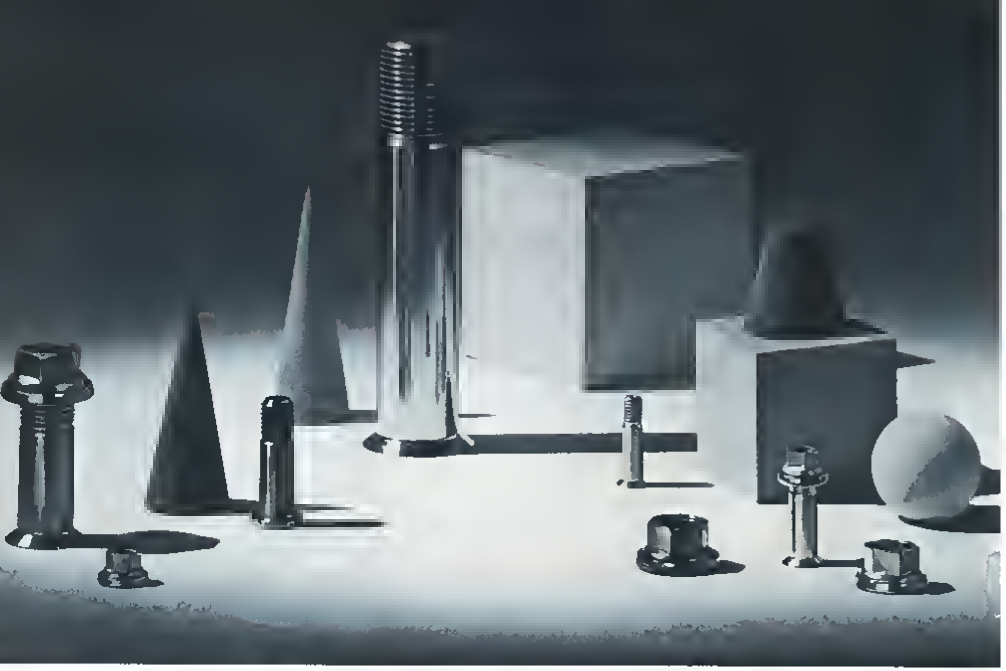
April 9, 1962

SPECIAL REPORTS:

- Pershing Missile
- Fuel Cells

Saturn SA-2 Stages Mated





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AEROSPACE CALENDAR

Apr. 16-18—Second Conference on Kinetics, Equilibria, and Performance of High Temperature Systems University of California, Los Angeles, Calif Sponsor Western States Section/Combustion Institute

Apr. 16-18—Second International Flight Test Instrumentation Symposium College of Aeronautics, Cranfield, England

Apr 16-18—Aerospace Systems Reliability Symposium, Institute of the Aerospace Sciences, Salt Lake City, Utah

Apr. 19—Eastern Regional Meeting, Institute of Navigation, Shoreham Hotel Washington, D C

Apr. 24-26—Polytechnic Institute of Brooklyn's Symposium on the Mathematical Theory of Automata, United Engineering Center, New York, N Y

Apr 25 29—Western Space Age Industries and Engineering Exposition, Cow Palace San Francisco, Calif

Apr 26-27—Quarterly Regional Meeting Assn of Local Transport Airlines, Hilton Inn, Atlanta, Ga

Apr 29-May 8—Hanover Air Show, Hanover, Germany

Apr. 30-May 1—Annual Meeting, National Aeronautical Services Assn., Shoreham Hotel, Washington, D C

Apr 30-May 2—Meeting on Manned Space Flight, Institute of the Aerospace Sciences Hotel Chase, St Louis, Mo

Apr 30 May 3—Design Engineering Show & Conference, McCormick Place Chicago

May 1-3—Spring Joint Computer Conference, Fairmont Hotel, San Francisco

(Continued on page 7)

AVIATION WEEK and Space Technology

April 9, 1962

Vol 76, No 15

Published weekly with an additional issue in December by McGraw-Hill Publishing Company James H. McGraw (1860-1948). Founder See panel below for directions regarding subscriptions or change of address. Executive, Editorial, Circulation and Advertising Offices, McGraw-Hill Building 330 West 42nd Street New York 36, N Y Printed at Albany, N Y. OFFICERS OF THE PUBLICATIONS DIVISION Nelson L. Bond President Shelton Fisher Wallace F Traendly Senior Vice Presidents John R Callaham Vice President and Editorial Director Joseph H. Allen, Vice President and Director of Advertising Sales A. R. Venezian, Vice President and Circulation Coordinator Daniel F Crowley Vice President and Controller OFFICERS OF THE CORPORATION Donald C McGraw President Hugh J Kelly, Harry L. Waddell Executive Vice Presidents L. Keith Goodrich, Executive Vice President and Treasurer, John J Cooke, Vice President and Secretary

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AEROSPACE CALENDAR

(Continued from page 5)

May 1-3—Biologistics for Space Systems Symposium, Biltmore Hotel Dayton, Ohio Sponsor Aerospace Medical Research Laboratories Aeronautical Systems Division AF Systems Command Wright Patterson AFB, Ohio

May 2-4—18th Annual National Forum American Helicopter Society, Sheraton Park Hotel, Washington, D C

May 2-11—International Space Research and Technology Exhibition, London, England Sponsor British Interplanetary Society

May 3-4—First International Congress on Human Factors in Electronics, IRE, Lafayette Hotel, Long Beach, Calif

May 7-9—Materials & Processing for Space Environments Symposium, Society of Aerospace Material and Process Engineers, Hotel Statler, St Louis, Mo

May 7-11—Annual Conference Society of Photographic Scientists and Engineers, Somerset Hotel, Boston, Mass Co sponsor AF Cambridge Research Laboratories

May 7-11—1962 Tool Exposition & Engineering Conference, Public Auditorium, Cleveland, Ohio

May 8-10—12th Annual Electronics Components Conference, Marriott Twin Bridges Motor Hotel, Washington, D C

May 8-10—Second National Conference on Peaceful Uses of Space, Seattle, Wash Sponsor National Aeronautics and Space Administration

May 11-12—Western Regional Convention, Air Traffic Control Assn, Senator Hotel, Sacramento, Calif Fly In Mather AFB

May 14-16—National Aerospace Electronics Conference, Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio

May 14-16—Joint Technical Society Department of Defense Symposium on Thermionic Power Conversion, Antlers Hotel, Colorado Springs, Colo

May 14-17—21st Annual National Conference, Society of Aeronautical Weight Engineers Benjamin Franklin Hotel, Seattle

May 16-18—Spring Meeting, Society for Experimental Stress Analysis Sheraton Dallas Hotel Dallas, Tex

May 17-18—Spring Meeting, Jet Testing Assn, Allison Division General Motors Corp, Indianapolis Ind

May 20-24—Annual Conference American Assn of Airport Executives, Ambassador Hotel, Los Angeles, Calif

May 20-26—Annual Meeting Aviation/Space Writers Assn Mark Hopkins Hotel, San Francisco, Calif

May 21-22—Annual Meeting and Aviation Fire Safety Seminar National Fire Protection Assn, Sheraton Hotel, Philadelphia, Pa

May 21-25—Second Annual Air Transportation Conference, New York University, Washington Square Center New York N Y Co-sponsor International Transport Institute

May 21-25—Eighth Aerospace Instrumentation Symposium and National Telemetering Conference, Sheraton Park Hotel, Washington D C

May 22-24—Conference on Self-Organizing Systems, Museum of Science and Industry, Chicago Ill Sponsor Office of

(Continued on page 9)

AEROSPACE CALENDAR

(Continued from page 7)

Naval Research, Armour Research Foundation

May 22-24—National Microwave Theory & Techniques Symposium, Institute of Radio Engineers, Boulder, Colo.

May 24-26—Seventh Region Conference on Space Communications, Institute of Radio Engineers, Seattle, Wash.

May 30-June 2—14th Annual Wright Memorial Glider Meet. For information Soaring Society of Dayton, Inc., Far Hills Branch, P. O. Box 581, Dayton 19, Ohio.

June 6-7—Symposium on Standards for Filament Wound Reinforced Plastics, Naval Ordnance Laboratory, Silver Spring, Md.

June 6-8—Eighth Annual Radar Symposium (classified secret), Institute of Science and Technology's Radar Laboratory, University of Michigan, Ann Arbor.

June 8-9-13—13th National Maintenance and Operations Meeting, Reading Aviation Service, Inc., Reading, Pa.

June 13-15—Annual Meeting, Heat Transfer and Fluid Mechanics Institute, University of Washington, Seattle, Wash.

June 18-Aug. 10—Advanced Subject Matter Institute on Nuclear Rocket Propulsion, University of Florida, Gainesville, Fla. Sponsor, National Science Foundation.

June 19-21—39th Meeting, Aviation Distributors and Manufacturers Assn., Ambassador Hotel, Los Angeles.

June 19-22—Summer Meeting, Institute of the Aerospace Sciences, Ambassador Hotel, Los Angeles, Calif.

June 20-22—Annual Convention, Airline Ground Transportation Assn., Barclay Hotel, New York, N. Y.

June 25-27—Sixth National Convention on Military Electronics, Institute of Radio Engineers, Shoreham Hotel, Washington.

June 25-30—Symposium on Electromagnetic Theory & Antennas, Copenhagen, Denmark. Sponsors, Technical University of Denmark, International Scientific Radio Union.

June 27-28—Ninth Annual Symposium on Computers and Data Processing, by the University of Denver's Denver Research Institute, Elkhorn Lodge, Estes Park, Colo.

June 27-29—Joint Automatic Control Conference, Institute of Radio Engineers, New York University, New York, N. Y.

July 17-19—Lunar Missions Meeting, American Rocket Society, Pick Carter and Statler Hilton Hotels, Cleveland, Ohio.

Aug. 10-11—Future of Manned Vehicles in Air and Space, Institute of the Aerospace Sciences, Olympic Hotel, Seattle, Wash.

Aug. 21-24—Western Electronics Show and Conference, Institute of Radio Engineers, Los Angeles, Calif.

Aug. 21-Sept. 17—14th Session, International Civil Aviation Organization Assembly, Rome, Italy.

Aug. 27-Sept. 1—Third International Congress, International Council of the Aeronautical Sciences, New Congress Hall, Stockholm, Sweden.

Sept. 3-9—1962 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 10-14—Annual General Meeting, International Air Transport Assn., Dublin, Ireland.

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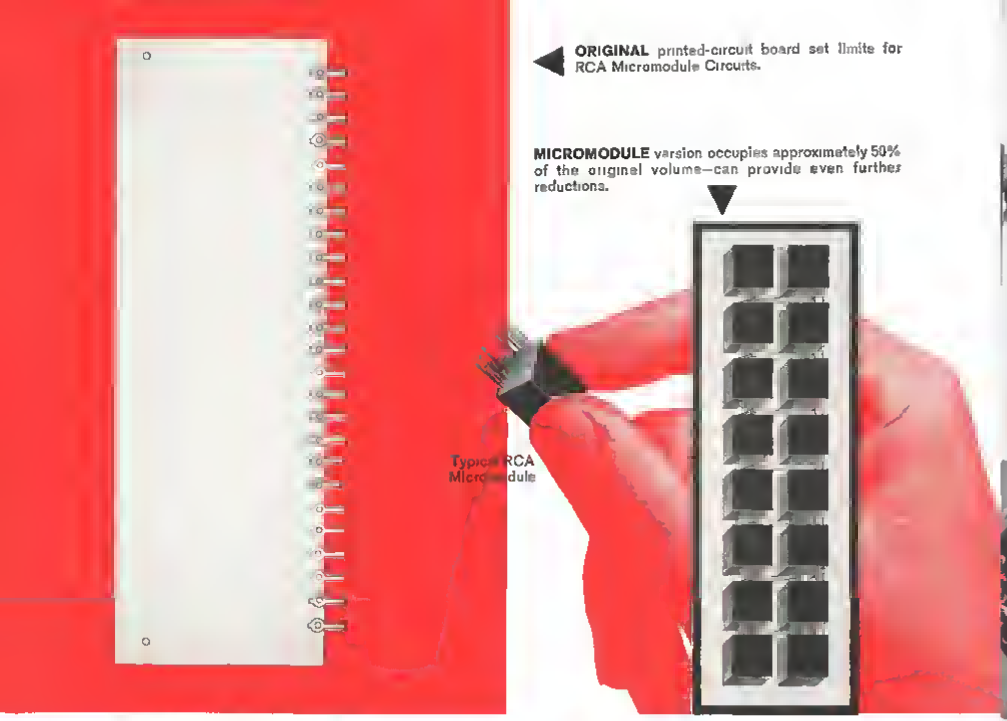

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LOWER COSTS. If you are looking for cost reductions as well as microminiaturization, RCA Micromodules can now show you the way.

CALL TODAY: Like to know how fast your circuits can be converted to Micromodules? Call your local RCA Office today for details on RCA Micromodules (and the RCA Micramodule Laboratory Kit for building prototype Micromodules in your own plant). For literature, write RCA Semiconductor and Materials Division, Commercial Engineering, Section D-112-NN-1, Somerville, N. J.

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RCA The Most Trusted Name in Electronics

Showoff

The Amphenol Minni E® connector does more than conform to MIL-C-5015. On the really important points it far exceeds requirements.

For example: during and after a twenty-day moisture resistance test, Minni E insulation resistance is 1,000 megohms minimum. 100 megohms is plenty to meet the specifications. Minni E's withstand 2,000 cycles of vibration testing at 20 g's. MIL-C-5015 specifies 500 cycles. And, after three cycles of grueling altitude-immersion testing, Minni E's have an insulation resistance of 1,000 megohms. MIL-C-5015 doesn't even contain an altitude immersion test requirement.

It's tough enough just meeting specs. Why deliberately design connectors to exceed them?

Dependability is why.

Amphenol engineers use specs as a starting point—not the last word. If their experience in connectors (how to design them for what they'll have to do) tells them added performance is needed—added performance is added.

That's the only way we can be certain of getting the highest possible dependability built into connectors.

A wealth of technical information on Amphenol Minni E connectors is yours for the asking. Just write Dick Hall, Vice President Marketing, Amphenol-Connector Division, 1830 S. 54th Avenue, Chicago 50, Illinois. Or, if you prefer, contact an Amphenol Sales Engineer or Amphenol Industrial Distributor. He'll be happy to "show off" the Amphenol Minni E.

AMPHENOL **Connector Division** / Amphenol-Borg Electronics Corporation

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

The Effect of Lead in Alloy Steels, PART I

The subject of leaded alloy steels will be discussed in two parts. Here we deal with basic definition, reason for excellent machinability, and purpose of closely controlling the lead additive. Part II, which follows in this series, will touch upon working properties, and discuss when leaded alloy steel should be used.

WHAT IS A LEADED STEEL?

A leaded steel is any steel, carbon or alloy, to which lead has been added to improve its machining characteristics. This lead additive, generally held within the limits of .15 to .35 per cent, may be added to any standard AISI or SAE steel. The percentage of lead does not, to any practical degree, alter the mechanical properties of the base steel.

HOW LEAD IMPROVES MACHINABILITY

Theoretically, lead has an inherent self-lubricating action which reduces friction at the tool-chip interface. This permits appreciably higher cutting speeds and feeds because leaded steels have a lower coefficient of friction than non-leaded steels. Also, because of the finely dispersed lead particles, there are minute interruptions within the matrix which cause a premature breaking of chips. This minimizes build-up within the tool-chip interface, prolonging tool life and improving machined finishes.

Optimum cutting speeds are commonly increased by 25 to 40 per cent. Sometimes, depending upon the condition and grade of steel and the type of machining, these speeds can be more than doubled.

LEAD ADDITION MUST BE CLOSELY CONTROLLED

Lead is distributed throughout the ingot by the addition of pure metal shot. It is forced into the molten-steel stream during teeming (pouring from the ladle to the mold) by means of a fixed air-pressure gun. The lead shot, having a higher specific gravity than the molten steel, tends to segregate at the bottom of the ingot. This is controlled by pouring a predetermined amount of steel in the ingot prior to the lead addition.

Since the uniform distribution of lead is all-important to the machining properties of leaded alloy steels, Bethlehem exercises great care in (1) controlling the lead content through checking by the fluorescent X-ray method, and (2) inspection of billet specimens for lead distribution by means of exudation tests.

Bethlehem metallurgists are "on the scene" where new applications of leaded alloy steels are being developed. If you'd like to consult with them on any problem, just write to us at Bethlehem, Pa. And remember, too, that Bethlehem makes a full range of AISI standard grades, as well as special-analysis steels, and all hot-rolled carbon grades.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts About Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

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April 9, 1962

Aviation Week and Space Technology

Vol. 76, No. 15
Member ABP and ABC

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EDITORIAL

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COVER—Inert second stage is mated to the Saturn SA-2 test booster at Complex 34, Atlantic Missile Range, as preparations are being made for the second in a series of development launches of the booster. Inert second stage simulates the weight and characteristics of the Douglas S-4 stage, to be powered by six Pratt & Whitney RL10-A3 engines. Third stage will be used only for escape missions. Under development by General Dynamics/Astronautics, it will be powered by two RL10-A3 engines and is designated S-5. The Saturn C-1 will be used for development flights of the Apollo spacecraft, including manned earth orbital flights of the three-man vehicle.

PICTURE CREDITS

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97,653 copies of this issue printed.

EDITORIAL

A Wise Decision

Decision of the seven Mercury astronauts to refuse the gift of seven homes plus furnishings in a Houston housing development on the grounds of a possible public misunderstanding of the motives of both the givers and the men who accepted is, we believe, a wise one. The case of the Houston houses has also served to focus a public spotlight on a drift toward the commercialization of the seven original astronauts and their achievements—a trend that if allowed to go unchecked would eventually contribute significantly to dissipating the tremendously beneficial effects of their work on this nation and the world.

It is obvious from the game of fumble ball played for some three weeks over the Houston houses that the top level officials of the National Aeronautics and Space Administration have been too lax in their supervision of the astronauts' extra curricular activities. They failed to provide the astronauts with proper guidance beyond the bare issue of legality until a public crisis erupted under their complacent swivel chairs. It is also obvious from the public comments of their lawyer, C. Leo DeOrsey, that however shrewd his legal advice may be, the astronauts need a better source of guidance on matters of public taste. Mr. DeOrsey's reason for reversing his original recommendation that the astronauts accept these free homes in Houston was that "if it is distasteful to the boss, the least you can do is to go with him ... it didn't take too much brains to figure out that you're going to get the boss mad if you accept the houses." It doesn't take too much brains either to figure out that this is a shabby reason to offer for the astronauts' action, and the public—both in this country and abroad, where their achievements have excited such tremendous admiration—would prefer to believe that their declination was based on a simple judgment of good taste.

Problems of Success

The astronauts are now treading down a glorious and dangerous path in the pitiless glare of public scrutiny that, on the one hand, makes their contribution to the prestige of this nation so much more effective than if it were carried out under the cloak of Soviet secrecy and, on the other hand, is a source of considerable personal annoyance to them. They are going to need all of the sage guidance and public sympathy they can get if they are not to tumble from their pedestals, as have so many American idols before them, and turn the current respect for their work and themselves into bitterness and gall. Success in any endeavor is always corrosive. The current success of Project Mercury has presented the astronauts with a vastly different set of public and ethical problems than those they faced in their training period.

Much of the astronauts' guidance in this admittedly ephemeral area of good public taste must come from their superiors in the government, from President Kennedy on down through the top strata of NASA. In the explosive growth of the national space program, financed by the taxpayers' dollars, there are many opportunities for corruption, questionable ethics and major conflicts of interest. If the astronauts see activity of this sort—that still skirts the borderline of illegality but violates other canons of morality—anywhere around them in NASA, the legislative or executive branch of the government, it could easily raise doubts about their own future course of conduct. If there is this sort of activity within the national space program, it will eventually boil to the surface and inflict irreparable damage not only on this technical endeavor, but also to the United States international prestige. As the size of the space bill climbs into the multi billions, even a faint whiff of corruption will be enough to collapse public support.

So the astronauts are not the only people in the space program who face a continuing ethical responsibility as its achievements and costs grow apace. But, because they are in the sharpest focus of public interest in the space program, they must bear a special responsibility to their countrymen to refrain from turning their technical achievements into commercial exploitation that will tarnish not only them but also the nation.

Another Reconsiderotion

Although Mr. DeOrsey says he sees no possible conflict of interest in the investment of the astronauts' funds in the Cape Colony motel at Cape Canaveral, we wonder if this judgment will require eventual reversal, as did his recommendation on the Houston homes.

Lt. Col. John "Shorty" Powers, Mercury public relations officer, made a moving plea at the press conference announcing the Houston homes decision for the press, radio and television to respect the privacy of the astronauts. But that plea would only be valid if the astronauts had not sold what Mr. DeOrsey specified as the "rights to their personal stories" to a national magazine for a half million dollars and permitted representatives of that magazine to go inside the Glenn home to photograph and publish the naked emotions of his family during his flight for the exclusive benefit of its subscribers, while the rest of the press waited respectfully outside.

The astronauts face a period of difficult problems in reconciling their personal problems with their public achievements without damage to either themselves or the image of their country which they have projected so successfully around the world. In addition to their own stout moral fiber, they will need the best advice they can get from their superiors to avoid further incidents similar to the public fumbling over the Houston homes decision.

—Robert Hotz

WHO'S WHERE

In the Front Office

Herold K. Pedersen, treasurer, General Dynamics Corp., New York, N. Y.

Theodore Van Meter, vice president, general counsel, Vickers, Inc., Detroit, Mich., a division of Sperry Rand Corp.

W. E. Thomas, president, Magnaflux Corp., Chicago, Ill., a subsidiary of General Mills.

John F. Harrison, vice president-general manager and chief executive officer, Eldema Corp., El Monte, Calif., a subsidiary of Cerusco, Inc.

James F. Hudson, vice president-advanced planning, Mesa Scientific Corp., Hawthorne, Calif.

Richard H. Horning, vice president-marketing, Hexcel Products, Inc., Berkeley, Calif.

Howard K. Schoenwetter, vice president-engineering, General Devices, Inc., Princeton, N. J.

H. C. Tittle, vice president-operations planning, Sylvania Electronic Systems, Waltham, Mass., a division of Sylvania Electric Products, Inc. **E. J. Vigneron** succeeds Mr. Tittle as vice president-general manager of the Division's central operation, Buffalo, N. Y.

Robert L. Sicard, assistant vice president-technical services, Northeast Airlines, Inc.

Washington Technological Associates, Inc., Rockville, Md., has named the following vice presidents: **William H. Simmet**-marketing; **Richard E. Nearman**-engineering; **Wendell C. Swenson**, comptroller.

Carl B. Squier, a director, Aviation Employees Corp., Silver Spring, Md. Mr. Squier is a consultant to Lockheed Aircraft Corp. and a director.

Grover D. Rogers, treasurer, and **Raymond Tremaine**, secretary, Canoga Electronics Corp., Van Nuys, Calif.

Honors and Elections

Gen. Bernard A. Schriever, Commander of the Air Force Systems Command, will receive an honorary Doctor of Engineering degree from Polytechnic Institute of Brooklyn on Apr. 28, and **Dr. Alan T. Waterman**, director of the National Science Foundation, will receive an honorary Doctor of Science degree.

Mrs. Constance Wolf has been named the recipient of the Federation Aeronautique Internationale's 1961 Montgolfier Award for her nonstop balloon flight from Big Springs, Tex., to Boley, Okla., last November.

Louis Polk, board chairman of The Sheffield Corp. and director and vice president of The Bendix Corp., has been awarded the Lt. Gen. Leon B. Campbell, Jr., Gold Medal of the American Ordnance Assn. in recognition of his outstanding service to armament preparedness of the United States.

A. R. Tocco, manager of value engineering for Space Technology Laboratories, has been elected president of the Society of American Value Engineers, succeeding **Lawrence D. Miles**, manager of value analysis services for General Electric Co.

(Continued on page 123)

INDUSTRY OBSERVER

► Second look at UK-1 international satellite and its proposed launchers has determined that U. S. will stay with the Delta vehicle for its first attempt scheduled for tomorrow. There was last minute concern that a Thor-Agena B would be required to orbit the 165-lb. satellite (AW Mar. 26, p. 13).

► Ranger 4 launching now is scheduled for the week of Apr. 22. Shot will be another attempt at a moon impact, carrying the same payload as Ranger 3 (AW Feb. 5, p. 30). Jet Propulsion Laboratory is studying feasibility of adapting future Rangers to mount payloads for earth-surveillance capability.

► First drop and live firing of USAF/Douglas Skybolt air-launched ballistic missile from Boeing B-52 is scheduled for late this month; guided, operational-type launching is likely to follow in November. Target operational date for first squadron is November, 1964. Skybolt retains electrically heated blankets to protect propellants against temperature change.

► Russian methods of calibration and error analysis for radar data submitted to Federation Aeronautique Internationale (AW April 2, p. 61) on Gherman Titov's orbital flight have been described as "very good" by non-Soviet observer. Belief is that Russians either take more care than U. S. does in these areas, or are as technically advanced as U. S.

► Communications package for self-erecting manned space laboratory will be studied in a contract probably to be awarded soon by North American Aviation's Space & Information Systems Division. Communications system would link the space lab to ground stations as well as provide internal communications. NAA is studying lab feasibility under NASA contract.

► Anti-satellite weapon system, armed with non-nuclear warhead or kill mechanisms, will be studied in a seven-month program to be sponsored by USAF's Space Systems Division. Weapon would be rocket-launched from earth bases to intercept and knock down unfriendly satellites.

► Navy is planning a ship-to-shore missile, designated Terror, in a class with Army's Missile B. but has not yet allocated any funds to start a program.

► Spacecraft escape system using extendable rotary wings, with blade tanks feeding tippets for final easy letdown, has been investigated with promising results by Northrop's Ventura Division. Feasibility tests were made with sizable scale models at Antelope Valley, Calif.

► Boeing's current concept for TFX fighter probably will be continued in follow-on study without reorientation, even though design may not be readily adaptable to installation of P&WA JTF10A engine selected for the plane.

► Series of aeromedical experiments to provide data for the Gemini program will start soon in the two-man space cabin simulator at USAF's Aerospace Medical Division, Brooks AFB, Tex. NASA has requested the studies, which will include the effects of prolonged breathing of pure oxygen.

► Extensive igniter research program conducted by Hercules ABL and Naval Ordnance Laboratory has resulted in several successful firings of the Altair 2 and eliminated the need to seek a second research and development source for the advanced fourth-stage Scout motor (AW Dec. 18, p. 31). NASA requested bids for second source in December, but stipulated contract might not be fulfilled if Hercules solved ignition problems.

► Revised mobile medium-range ballistic missile program specifications (AW Apr. 2, p. 22) were to be reviewed early last week by a Pentagon representative. If approved, requests for proposals probably will be issued this week.

► Russians are developing theoretical designs of annular nozzles for supersonic gas flow. This type, which includes the "spike" already tested on several U. S. rocket engines, has been analyzed on the Strela high-speed electronic computer at Moscow State University.

Washington Roundup

McNamara's Troubles

Secretary of Defense Robert McNamara, fresh from a fight with the House over the RS-70 bomber, has severely strained his relationships with some key members of the Senate. He infuriated Chairman Willis Robertson of the Senate Appropriations Defense Subcommittee last week by directing Air Force witnesses to restrict themselves to a statement on the RS-70 that McNamara himself had helped prepare just before the hearings began. Sen. Robertson, a champion of military officers' right to express their own opinions before Congress, refused to hear the McNamara statement and told AVIATION WEEK he felt McNamara had exerted undue pressure on the Air Force. Later that day, however, McNamara and Air Force Secretary Eugene Zuckert called on Sen. Robertson together and promised to supply any information the subcommittee wanted. This satisfied Sen. Robertson but left lingering resentments within the subcommittee.

Meanwhile, Chairman Carl Vinson of the House Armed Services Committee said he is "very much encouraged" by the makeup of the group named by McNamara to restudy the RS-70 program (AW Apr. 2, p. 15). "The question now is whether the scientific and technical people will say the RS-70 can do what [USAF chief of staff] Gen. LeMay says it can," Rep. Vinson said.

New Soviet Leaders

Seven of Russia's leading aircraft designers and half a dozen key military men have been elected to the Supreme Soviet (parliament) of the USSR. The designers are V. M. Miasishchev, P. O. Sukhoi, O. K. Antonov, A. I. Mikoyan, A. N. Tupolev, A. S. Yakovlev and S. V. Ilyushin. Others winning Supreme Soviet seats in the recent uncontested election include Cosmonauts Titov and Gagarin; M. V. Keldysh, president of the Academy of Sciences; Marshal Rodion Malinovsky, Minister of Defense; P. V. Dementiev, chairman of the Council of Ministers' State Committee on Aviation Technology; Chief Air Marshal K. A. Vershinin and Air Marshals Sudets, Yevgeny Savitsky, Sergei Rudenko and Nikolai Skripko. Vershinin, Rudenko and Sudets also are among the 12 military officers now on the 175-man Communist Party Central Committee, Russia's top political body (AW Nov. 13, p. 25).

Warren J. North will become director of the Flight Crew Operations Division at NASA's Manned Spacecraft Center in Houston, Tex., with responsibility for astronaut training and crew integration on the Gemini and Apollo vehicles. A former NASA test pilot, he was assistant chief of manned satellite programs at headquarters and has gone through the entire astronaut training program with the Mercury pilots. He scored among the top candidates in the original selection.

Russian Space Denials

Russia has become extremely defensive about U.S. attitudes on the Soviet space program, probably due largely to the favorable impression the U.S. has made abroad by allowing complete press coverage of Mercury flights. Leonid I. Sedov, head of the USSR Academy of Sciences' space committee and past president of the International Astronautics Federation, took the unusual step of writing an article denying a U.S. columnists' report that five cosmonauts have died in the Soviet space program, and Cosmonaut Gherman Titov, who appeared before university students, denied "statements appearing of late in the foreign press" that he is suffering from radiation sickness as a result of his flight in Vostok 2 last August.

Non-profit tax status of several technical societies that use outside, profit-making firms to handle the lucrative business of renting exhibit space at conventions is under investigation by the Bureau of Internal Revenue.

Sen. Wayne Morse, Capitol Hill's foremost filibusterer, plans to try to talk the communications satellite bill to death when it reaches the floor. He feels the system should be publicly owned and thinks international implications are so great that the Secretary of State should testify. In spite of Sen. Morse, odds favor passage of the compromise version of the bill (AW Apr. 2, p. 20).

Transportation Message

President Kennedy's transportation message (see p. 42) **hit Congress so late in the session that it may well be shelved until next year.** Some of the objectives can be accomplished through executive orders. But there is a drive to adjourn early because of elections this year, and key congressmen—including Senate Commerce Committee Chairman Warren Magnuson—do not want to take on new controversies now.

Capitol Hill's interest in space is far from limited to the members of committees that review the National Aeronautics and Space Administration's budget. During March, congressmen sent NASA's Legislative Affairs Director Paul G. Dembling 362 requests for detailed answers to questions. As of Apr. 1 the backlog of such requests was 530. The office also receives an average of 125 telephone queries a day from congressmen.

Intramural aftermath of the astronauts' housing problems: Federal Aviation Agency Administrator N. E. Halaby introduced Dr. Hugh L. Dryden at a luncheon last week as "the deputy administrator of the National Aeronautics and Housing Administration."

—Washington Staff

NATO Cuts Choice to 4 VTOL Fighters

Dassault, Republic-Fokker, Hawker Siddeley, BAC designs remain; doubt raised over program future.

By Cecil Brownlow

Paris—Contenders in the North Atlantic Treaty Organization competition for a VTOL strike reconnaissance fighter have been pared to four.

Formal subcommittee level NATO recommendations are due by late next month but uncertainty is rising over the final prospects of success for the program as a whole.

Of the 11 proposals submitted prior to the competition deadline early this year (AW Jan. 22, p. 40), the four still under consideration by technical subcommittees within the NATO secretariat are:

- French Dassault Mirage 3V.
- Republic-Fokker D.24 variable sweep aircraft.
- Hawker Siddeley P.1150.
- British Aircraft Corp. proposal which also embodies the variable geometry concept (AW Apr. 2, p. 21).

Full evaluation committee, in turn, is scheduled to submit its recommendation or recommendations to the final arbiter, the politically-inclined NATO armaments committee, by early June. For political and technical reasons the proposal may suggest production of at least two prototypes, one embodying pure lift engines for VTOL performance, the other variable thrust powerplants that can be used for both vertical and horizontal flight.

All four aircraft still in the running substantially exceed NATO's present BMBR 3 requirement for a ground-support aircraft with a minimum on-the-deck performance of Mach .92 for a distance of at least 250 nm. High-altitude speeds of all are in the Mach 2 regime. This factor coupled with other developments along national lines lead some qualified observers here to believe that the program, if it survives intact, will evolve into a project for a high speed interceptor rather than a close support fighter.

West German Pressure

Need for such an interceptor plus a less sophisticated V/STOL aircraft with an earlier availability as a replacement for the Fiat G-91 is being pushed hard by West German defense officials who recently told NATO they plan to build on a national basis an aircraft that can effectively handle the latter mission—the Focke Wulf 1262.

An original entry in the BMBR 3 competition, the 1262 roughly fits present NATO specifications. Envisioned powerplants are a Bristol Siddeley BS.94 variable thrust engine plus two auxiliary Rolls-Royce RB.162 pure lift engines for use during VTOL take-off and landings.

BS.94, still largely a paper study without government support or funding, has a reported maximum thrust potential of some 27,500 lb., midway between the BS.53 which powers the transone Hawker Siddeley P.1127 now in flight development stage and the 38,000 lb. thrust BS.100 designed to go into the more sophisticated 1150 and the Republic-Fokker D.24.

The West Germans, whose defense budget already is under fiscal stress this year, have asked the United Kingdom to follow suit with a 1262 order for the Royal Air Force and Royal Navy plus financial support for the BS.94 under the aegis of a bilateral agreement for the mutual development of a close-support aircraft. The British, however, reportedly are maintaining that the P.1127 can do the job envisioned for the 1262 and that, since the aircraft already is in the hardware stage, it should be the basis for any common project.

Refusal on the part of the British to at least help pay development costs on the BS.94 could, some observers believe, seriously cramp the West German plan to build the Focke-Wulf design as presently conceived.

National Interests

The decision by the German Defense Ministry, which is still expressing its willingness to remain in the NATO competition, has aroused new fears as to the possibility of the program splintering along largely national lines. Such fears have accompanied the project since its inception, largely in view of French insistence that the Mirage 3V is a national program and will be developed with or without NATO backing.

On the brighter side is a recent modification by France of its position. The present stand is that the Mirage 3V, whose production models will incorporate four fuselage-mounted 6,000-lb.-thrust RB.162s for vertical lift, will be carried through prototype development but that, if another design can demonstrate a marked superiority, the 3V may be abandoned. The prototype, using earlier 2,000-lb.-thrust Rolls-Royce RB.108s, is currently scheduled to make its first flight sometime in June.

Another unknown is the U.S. position so far as its own defense needs and VTOL plans are concerned, plus the amount of financial support it is willing to give to any NATO program.

The latter is viewed as a necessity if the project is to develop beyond infancy, particularly in view of the planned participation by a number of NATO nations which rely primarily upon mutual aid funds for all or most large scale procurement buys.

Both official and industry observers agree that a general U.S. statement of position would mark a major step toward solidification of a program.

Engine Choice

Aside from roles and missions, another current dispute centers around the optimum type engine to be used, a factor in the general belief here that production of both a variable-thrust and lift-engine prototype aircraft may be recommended to the armaments committee where any final decision will be reached.

In the past, the U.S. has supported development of the BS.53 variable thrust concept with mutual weapons defense projects funds, and U.S. Air Force technical teams have aided in the NATO headquarters' evaluation of the various designs for the fighter and a V/STOL medium range transport.

U.S. officials insist, however, that they will remain aloof from the political in-fighting for adoption of national designs and throw their support behind the proposals that prove to be the most technically feasible and promising regardless of origin.

British Watch Market

The British, while pushing the P.1127 within Germany and elsewhere as a VTOL close-support fighter, also plan a frontal attack on any developing VTOL interceptor market within and outside NATO—either with the Mach 2 plus P.1150 or the more advanced British Aircraft Corp. project under development by Vickers-Armstrongs. Using variable sweep and making use of available U.S. National Aeronautics and Space Administration research in this area as well as Vickers' own work in the field, the latter project was given a recent boost by a British Ministry of Aviation design study contract to BAC (AW Apr. 2, p. 21).

Still in preliminary design, the aircraft reportedly has a maximum weight within the 50,000-lb. category and is being designed for operation from shipboard as well as land in line with a joint RAF-Royal Navy competition. Republic-Fokker also is designing a ship-based version of the D.24 in an effort to penetrate the British market.

NATO V/STOL Transport Study Narrowed

Paris—NATO design study competition for a V/STOL medium-range transport reportedly has been narrowed to five proposals split between the two most prominent design concepts—turbojet vs. turboprop. From the welter of bids submitted last fall (AW Nov. 27, p. 23), NATO evaluators are believed to be weighing the merits of these five finalists:

- Ling-Temco-Vought design based largely upon the tilt-wing proposal adopted in the U.S. as the tri-service VTOL transport (AW Sept. 25, p. 35?). Powerplants are four General Electric T64 turboprops. Proposed partners include Ryan, Hiller, Sud Aviation and Italy's Fiat.
- Bristol Aircraft Corp. design built around a scaled-down version of the BAC 208 transport in partnership with Dornier of Germany and Industrie Meccaniche Aeronautiche Meridionali Aerfer in Italy. Basic powerplant is the Bristol Siddeley BS.53 variable thrust engine.
- Hawker Siddeley Group proposal, one of several submitted in the competition. Present interest probably centers around a version of the Armstrong Whitworth 681 using the BS.53.
- De Havilland of Canada's proposal for a Mk.2 version of its Caribou turboprop transport.
- France's Breguet design based upon a blown-wing version of its 941 STOL transport.

Observers here believe that a design study contract may be awarded to at least two of the finalists in order to further evaluate the performance differences and capabilities of the turboprop and turbojet principles in the V/STOL transport field.

West Germany also apparently intends to continue funding of its own design in the V/STOL transport area, the Dornier Do 31 incorporating a BS.53 podded beneath each wing, which also was an entry in the NATO competition. A total of $30 million reportedly has been earmarked for the project thus far.

Navy Requests V/STOL Estimates

Navy Bureau of Weapons was to receive cost estimates today from Douglas Aircraft Co. and Bell Aerosystems Co. on V/STOL transport designs based on, but modified from, original tri-service V/STOL transport competition designs.

Technical data was submitted Apr. 2. Decision is due within six weeks. Navy says winner of the competition will get a funded contract for further study only, but Bell plans to build two prototypes if it wins.

Bell and Douglas were the only entrants in the competition. Sikorsky, Piasecki and North American's Columbus Division were invited to enter, but declined. Navy apparently is seeking smaller aircraft than that envisioned as the tri-service V/STOL transport. That competition was won by the team of Vought-Hiller-Ryan and the aircraft is in Phase One development. Lockheed-Georgia no longer is teamed with Bell as in the tri-service VTOL competition.

BuWeps considered that approaches taken by Douglas and Bell in the original competition warranted further study and issued a request for proposals.

Bell's Model D.2127 would be powered by four General Electric T58 engines, mounted two to each side in stubby aft wings and interconnected. Engines drive rotating ducted propellers at each of the four corners of the aircraft.

Aft ducts have been moved farther outboard than those in the original design (AW May 1, p. 32) to prevent overlap and increase speed and lift. Engines were moved from the fuselage in the original aircraft to the wings to allow more cargo space. Current Bell proposal would seat 10 passengers. Gross weight has been reduced from 35,000 lb. in the original aircraft to approximately 15,000 lb. in the new proposal.

The cockpit has been redesigned along helicopter lines to permit better downward visibility. Most changes have been made as a result of extensive wind tunnel tests which were continued after the original V/STOL competition award was made.

Stabilization work on the Bell proposal was done in connection with Cornell Aeronautical Laboratory, Inc.

Douglas entry is a high-wing canard configuration with four rotating ducted propellers located on wing tips at the four corners of the aircraft. Propellers are shaft driven by four turbine engines mounted in the fuselage.

Design was largely worked out in company-funded development program which continued studies after the original tri-service competition ended.

Compromise Comsat Ownership Plan to Be Supported by AT&T

Washington—American Telephone & Telegraph Co., which will probably be the biggest investor in a commercial communications satellite system, and its biggest user, plans to support the compromise ownership plan that has been worked out by the Administration and congressional committees.

This would provide for 50-50 financing by communications common carriers and the general public through purchases of stock at a maximum price of $100 a share (AW Apr. 2, p. 20).

A spokesman for AT&T last week told AVIATION WEEK that "we still believe that complete ownership by the common carriers would be the best way to achieve service to the customer at the lowest cost and with the most speed. However, we are political realists. The Administration and key members of Congress feel the compromise plan is the best arrangement that can be agreed upon, and we are prepared to accept it."

The only roadblock to early enactment of legislation establishing the profit-making corporation to develop and operate the satellite system now appears to be a small but determined group of senators, led by Sen. Estes Kefauver (D-Tenn.), favoring government ownership. This group is expected to aim at forestalling any action this session.

Senate commerce committee will start its hearings on the compromise legislation, already unanimously approved by the Senate space committee, on Apr. 10. House commerce committee has already completed hearings.

The measure gives the President and Federal Communications Commission extensive authority over the proposed communications satellite corporation.

The President is directed to "aid in the development and foster" the satellite program, provide for continuous review of all phases, and coordinate all related government activities.

FCC would have authority over the technical characteristics of the operational system and the ground stations and could require the corporation to establish facilities at foreign points in the interest of U.S. policy objectives.

Homes for Astronauts Stir Ethics Issue

By Edward H. Kolcum

Washington—General tightening of ethical standards in government agencies and closer official control by these agencies will result from the controversy generated by the offer, acceptance and subsequent refusal of free homes in Houston, Tex., for the seven Project Mercury pilots.

The houses, valued at $24,000 each, plus furnishings, were offered by the Houston Home Builders Assn. in what was characterized as a way to welcome the astronauts to their new home. National Aeronautics and Space Administration's Manned Spacecraft Center is under construction near Houston. The homes were accepted by Leo DeOrsey, a Washington attorney who represents a number of show business personalities and handles the personal business affairs of the astronauts.

DeOrsey finally declined the homes in the face of growing pressures from the White House, Congress and NASA. Spokesmen at both the White House and NASA admit the taint of commercialism and promotion has been potentially damaging to the prestige of the space program and the U.S. image—now largely embodied in the astronauts.

One NASA official blamed the affair specifically on the lack of communication between the astronauts and Dr. Hilden Cox, NASA's assistant administrator for public affairs. He forecast that as a result of the housing incident, the situation will be rectified with no need for written regulations. Cox, a botanist, was appointed to improve the public image of the space agency.

DeOrsey admitted he acted unilaterally in "recommending" acceptance of the Houston homes and said he had not obtained an indication from the astronauts of whether or not they wanted the homes. Although he said he told a member of the association he was going to recommend that the astronauts accept the homes, the impression in Houston was that he gave a final acceptance, and it was so reported in the press Mar. 30.

Congressional Reaction

Rep. George P. Miller (D.-Calif.), chairman of the House space committee, reacted immediately by saying he does not believe gifts of this kind "are in the best interests of the country."

Rep. James G. Fulton (R.-Pa.), a member of the committee, disagreed and said he saw the offer as "an expression of gratitude from a grateful people." He said there wasn't much difference between gifts of the houses to the astronauts and the presents sent to the President.

Among the first reactions to the Mar. 30 report was a call to NASA from Dr. Edward C. Welsh, executive secretary of the Space Council, who suggested it would be "unfortunate" if the astronauts accepted the homes. He learned that NASA as an agency had not been asked to approve acceptance of the homes, but had been asked for a legal ruling. "This was not enough for me," he said. "We really had a question of something which appears to be adverse."

There were others who questioned NASA's position on the free homes, because of President Kennedy's personal sensitivity on the ethical posture of the Administration. Although NASA determined it was not illegal for the astronauts to accept the homes, the incident came on the heels of reports that the astronauts had invested in the Cape Colony Motel, which will open June 1 in Cocoa Beach, Fla. (AW Mar. 26, p. 15).

Reaction to this report was highly critical, because obviously association of the astronauts with the motel would give it an advantage over other motels on the Cocoa Beach strip. During launches, rooms are difficult to find, but the motel business is highly competitive on the strip when there are no launches.

Kennedy's Views

President Kennedy's sensitivity to government officials using their positions for monetary gain was expressed in a special message to Congress last April. At that time he said he intended to prohibit gifts to government personnel if "the gift would not have been made except for his official position" or when the donor's private interests are likely to be affected by the employee or his agency. This has not been translated into a directive.

DeOrsey was firm in defense of his action in accepting the Houston homes. "I have not made a mistake on the question of good taste," he said. "I still think it was good taste. I haven't changed my mind. I would do it again."

The factor which resulted in the withdrawal of DeOrsey's recommendation that the astronauts accept was the question of taste raised by Cox and Lt. Col. John Powers, Manned Spacecraft Center public affairs director. Col. Powers said ethics did not enter into the decision, and added that the refusal was made by the astronauts and not by NASA, although NASA advised the pilots that "acceptance of the houses is not considered in the best interest of all concerned."

Glenn Advised

DeOrsey said he advised Lt. Col. John H. Glenn, Jr., "so far as I am concerned, if it is distasteful to the boss, the least you can do is go with him."

Frank Sharp, developer of the area in which the homes are located, said there would be "no strings attached" to the offer, but another Houston spokesman was regarded as more realistic in his comment that the houses are "the very best type of public relations."

DeOrsey said, however, "I thought that there was no promotional aspect involved as such because a group [Houston Home Builders Assn.] not even connected with the location where the homes were to be built was involved." He said that he was aware of only one offer of the homes, "and it was distinctly understood that there were going to be so many people involved that we would be below the gift tax limits."

Problem of precedence would certainly have arisen if the homes had been accepted. The White House and James E. Webb, NASA administrator, have clearly indicated that approval will not be given for future contracts like the one the astronauts signed with Life Magazine in August, 1959, for exclusive rights to their personal stories.

This contract was for $500,000, proceeds of which are being used for investment in the motel, an apartment project in Washington and a motel in Freeport, Grand Bahama Island. Webb said last week that five to 10 more astronauts will be selected soon for Gemini and Apollo programs, and the difference between benefits acquired by the original pilots and those to be chosen already is significant.

DeOrsey, who refers to the astronauts as "the boys," said not many offers were forthcoming after the Life contract until the Mercury-Redstone ballistic flight of Cdr. Alan B. Shepard, Jr. He said he has declined more than $500,000 for testimonials and endorsements, and "all gifts have been turned down."

"I see that the public press has given considerable space to their investments. Their investments are not any more than the investments that you or I make. They got no break as a result of the monies that they put up," he said.

Among the offers he has turned down, DeOrsey said, was one of a house for Shepard from Rep. Frank Boykin (D.-Ala.), which was made through President Kennedy. He said the White House turned the offer over to him without indicating "to me what policy I should follow."

There were other houses offered, DeOrsey said, and "I declined on the theory that I thought someone was trying to promote the boys and that I would not do."

Insurance people were writing in, were coming in to see me, and the gist of the letters was that they were pleased to inform me that their insurance company had been chosen to write insurance on the astronauts and that public-spirited American citizens were going to pay the premiums. Those I declined," he said.

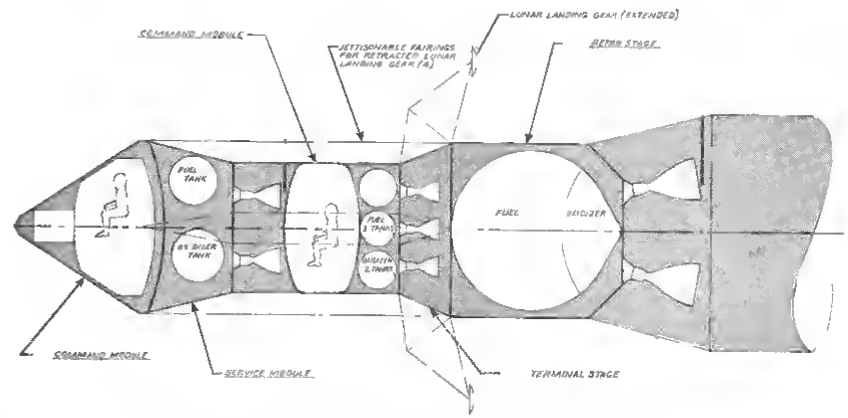
DeOrsey said he agreed to handle the business affairs of the astronauts on the request of Walter T. Bonney, former NASA public information director, only on the basis that he does not get paid and that he defrays his own expenses. He said he has a one-eighth interest in the astronauts' Washington hotel because the astronauts wanted him in the project.

In defense of the Life contract, DeOrsey said it was for the personal, not official, stories and that he is protecting "the same rights for these boys as General Bradley had, as General Montgomery had, as Anderson had when he went under the pole, and as President Truman and President Eisenhower had. But I would go further. I would not ask for any special tax benefits. The contract with Life calls for installment payments." He would not say how much the payments were, nor would he give a total figure for the astronauts' investments, telling a reporter, "I don't think that's any of your business, and I don't see where that's so important to the public."

Satellite Pact

London—First three nations interested in the proposed European space launcher development organization last week signed an agreement which will lead to detailed organizational planning of a de Havilland Blue Streak launch within two years.

Initial signatories are Great Britain, West Germany and Italy. Others expected to sign before Apr. 30 deadline are France, Australia, Belgium, Denmark and Holland. Blue Streak will be the first stage, with French second stage, and West German third stage. Italy is designing dummy satellite for the first test launching (AW Mar. 12, p. 277).



Proposed Lunar Rendezvous Apollo Shown

Lunar rendezvous, one of several techniques being considered by the National Aeronautics and Space Administration for the Apollo lunar landing mission, might incorporate a small, one or two-man capsule carried aboard the Apollo spacecraft. Artist's concept above shows possible Apollo configuration. NASA currently is conducting a competition for a lunar orbital rendezvous study; companies bidding are Douglas Aircraft Co., North American Aviation, Inc., and Space Technology Laboratories. With the lunar rendezvous technique, an Apollo spacecraft and its piggyback lunar descent module would be flown directly to the lunar vicinity by a single Saturn C-5 launch vehicle. The spacecraft would be injected into lunar orbit by use of the retro stage and the unit jettisoned. The lunar descent module would separate from the Apollo vehicle and fly a ballistic trajectory to the lunar surface, while the mother craft remained in lunar orbit. After exploring the moon, the pilot(s) would reboard the capsule and launch it into a lunar orbit there to rendezvous and re-assemble with the Apollo. Crew members would enter the main command module through the service module; the lunar descent capsule then would be jettisoned. Propulsion system within the service module—a single-barrel engine (drawing shows twin barrel engine) putting out about 20,000 lb. thrust and using hypergolic propellants—would then be used to take the Apollo spacecraft out of lunar orbit and place it on a return trajectory to earth. Service module would be jettisoned just prior to earth re-entry. Spacecraft with this over-all configuration would be about 50 ft. long, weigh approximately 55,000 lb. Lunar descent capsule would stand about 15 ft. tall, weigh about 12,000 lb. fully fueled.

Umbaugh Trial Stalled

Negotiations between Raymond E. Umbaugh and at least one member of a group of dissident distributors of Umbaugh Aircraft Corp. have caused postponement of hearings in a Baltimore, Md., court until Apr. 16.

Hearings resulted from charges by Umbaugh that the distributors were interfering in the activities of Umbaugh Aircraft and from counterchanges that Umbaugh had practiced fraud in getting the distributors to invest funds in the U-18 gyroplane project (AW Apr. 2, p. 18).

Negotiations were conducted last week in Ocala, Fla., between Umbaugh and Veigh Cummings of Salt Lake City, Utah. Umbaugh told Aviation Week that Cummings proposed a settlement which would be presented to the Umbaugh Aircraft directors this week.

In another action Umbaugh Aircraft Corp. and Peace River Corp. have deposited a total of $39,800 with a Florida court to purge themselves of a contempt finding. An appeal of the contempt citation also has been filed.

North American Builds Full-Scale Apollo Mockup

Apollo full scale model built by prime contractor North American Aviation, Inc., for the National Aeronautics and Space Administration shows over-all spacecraft configuration and arrangement of systems within the three man command module. Periscope and side access hatch are prominent in photo above, left. Above, right, a pilot stands in the air lock and entrance port at the spacecraft's apex. Cutaway of the preliminary mock up (right) shows three crew members lying in their couches in a launch position. Below, left, two pilots monitor the flight of the Apollo vehicle while the third crew member repairs a spacecraft part. One pilot flies the spacecraft (below, right), while the second sleeps in the rear of the module and the navigator takes a bearing. Full scale model stands approximately 12 ft. high and is about 13 ft. wide across the base.

NASA Plans Large Payload Booster Study

By Irving Stone

Los Angeles—NASA's Marshall Space Flight Center will sponsor an industry study to review the state-of-the-art for very large, post-Nova launch vehicles for availability in 1972 or later. Vehicles could be capable of launching Nova-size or larger payloads with greater efficiency than the first-generation Nova class vehicle as now envisioned (AW Apr. 2, p. 20).

Industry will submit proposals by Apr. 16 in a competition for this post-Nova study, in response to Marshall's request for quotation No. TP2-74012. It is estimated that the study will involve 6,000 direct engineering man-hours and will run for a period of six months under a cost-plus-fixed-fee contract.

For comparative data, Marshall specifies that the first generation Nova class vehicle will become operational within the 1965 to 1970 span and will carry approximately 400,000 lb. of payload to a low-altitude orbit as a two-stage chemical rocket or about 160,000 lb. to escape speed as a three-stage chemical vehicle. This escape capability would almost be doubled if a nuclear third stage were used.

Apollo Program

This expendable Nova vehicle will be used in the Apollo program, in the establishment of large space stations, establishment and supply of a lunar base, and in earth planetary missions if these are included in the National Space Flight Program.

For purposes of projections and comparisons in the post-Nova study, MSFC specifies that these following assumptions and guidelines will be used for the first-generation Nova:

- **Development** of the Nova vehicle, now in preliminary design stage, will be initiated early in 1963.
- **It will deliver** the 400,000 lb. payload to low altitude earth-orbit for a direct operating cost of approximately $100 per pound of payload.
- **It will propel** the 250,000 lb. payload to escape speed at a direct operating cost of about $200 per pound.
- **Mission reliability** will not exceed 90% for earth-orbit missions and 80% for earth escape.
- **Nova launch facilities** at the Atlantic Missile Range will provide a firing capability of 12 vehicles per year.

First phase of the post-Nova study will include a search for new concepts, a survey of advanced concepts already proposed and comparisons to select the most promising concepts for more detailed study.

MSFC points out that in the attempt to attain gross improvements in performance, reliability, and cost, most of the new concepts which have been proposed aim to achieve reduction in size for a specified payload by improvement of the basic propulsion system and/or structural mass-fraction, reduction in number of stages by improvement of structural mass fraction and specific impulse, increase in performance by improvement of structural mass-fraction and specific impulse, improvement in economy through recovery provisions to permit reuse of the entire vehicle or some of the parts, use of auxiliary take-off devices to improve payload capacity and improvements in reliability and development economy through segmentation of engine components.

Information Sources

MSFC specifies that information should be obtained directly from industry members that have proposed vehicle concepts in these categories, and that applicable information on government sponsored developments and studies will be supplied upon request to the contractor.

Results expected by MSFC in the post-Nova study include this specific coverage:

- **Identification** of areas of greatest potential improvement through basic analysis and review of previous launch vehicle programs.
- **Development** of criteria for realistic comparisons of concepts.
- **Summary descriptions** of vehicle concepts considered, with estimated capabilities and characteristics, both favorable and unfavorable, peculiar to each concept.
- **Comparisons** leading to selection of concepts recommended for more detailed study, with reasons for recommendations to exclude other concepts from additional investigation.
- **Conceptual** design and analysis of an attractive vehicle concept, selected with MSFC approval not to exceed 50% of the study effort. This area will include estimates of additional study and development required to establish feasibility of the concept together with the cost and schedule estimates for development.
- **Gross estimates** of post 1970 transport volumes and payload sizes for use in vehicle analyses.
- **Expected** trends of earth-orbit, earth-lunar and earth-planetary transportation costs, beginning with first generation Nova vehicles and extending into the time period of post-Nova vehicle availability.

Navy Studying TV-Guided Missiles

Los Angeles—Navy is investigating two separate television-guided air-to-surface missiles which can be directed to their targets by the pilot of the launch aircraft from a TV cockpit display while the aircraft is making an escape from the target area.

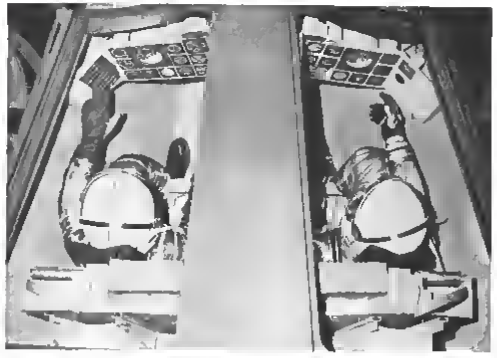
Naval Ordnance Laboratory at Corona, Calif., will be systems integrator for one of the missiles presently called Condor, to be funded through Navy BuWeps. While NOL Corona has been purchasing hardware for an experimental version, no partner ship by industry contractors is expected through Fiscal 1963.

Heart of the Condor system will be an automatic tracking TV system originally developed at Corona and further refined at Naval Ordnance Facility, China Lake, Calif. In this tracking system, known as Walleye, the camera lenses, located in the air launched missile, can lock onto an object, selected by the pilot from his cockpit display, and then feed target guidance information into the missile's guidance system.

The second missile, presently called Corker, will be an unpowered, air launched glide missile for which first feasibility studies are being conducted by the Naval Missile Test Facility at Pt. Mugu, Calif. The facility has a requirement from the Marine Corps for a lightweight, low-cost glide missile system for use by carrier-based aircraft. Once the Corker missile is released from its aircraft platform, it can be controlled from the aircraft from a range that would be defined by the altitude of the mother aircraft. Television guidance would be employed in the Corker missile as in Condor.

Navy's Air Missile Test Center, Pt. Mugu, is expected to make signal propagation studies for the Condor avionics systems to send signals from the missile's TV head to the launch aircraft and control signals from the aircraft to the missile. It also will investigate optimum frequencies for the system. Navy's avionics facility at Johnsville, Pa., is building a prototype communications link for Condor in what is believed to be an in-house effort.

Navy has previously studied a TV-guided air launched missile in the TVIG (television inertial guidance) phase of the Bullpup program, which utilized an adaptation of the Bullpup missile.



McDonnell Using Mercury Technology for Gemini

Same basic technology used for design of the Mercury capsule (smaller capsule, upper right photo), is being used by McDonnell Aircraft Corp for design of the Gemini two-man spacecraft. Major changes are the use of ejection seats instead of an escape tower in case of a launch or early flight abort, and scaling the afterbody to accommodate a Rogallo-wing for landing control (AW Apr 2, p. 17). There will be about 50% more volume in the pressure vessel, with all major systems stowed outside the cabin and accessible through side panels. Position of attitude jets is visible around the Gemini neck. Recesses in the spacecraft structure are to provide clear visibility necessary for final docking in development of rendezvous techniques. Gemini will be launched by a USAF-Martin Titan 2. It will be the chaser in the rendezvous mission, with a previously-launched Agena stage the target.

House Unit Backs NASA on Solid Rockets

Washington—National Aeronautics and Space Administration has won the first round in this year's fight in Congress over whether the space agency should spend more money on solid rocket propulsion.

Chairman Victor L. Anfuso (D-N.Y.) of the House Science and Astronautics Subcommittee, which held extensive hearings on the solid vs. liquid controversy, told AVIATION WEEK that he is now satisfied that the U.S. is pursuing an adequate national program to develop solid motors.

His statement came after NASA officials in private meetings argued against increasing the budget for solids. Despite industry claims to the contrary, these officials said the combined work of NASA, Air Force and the Defense Department's Advanced Research Projects Agency represented a very substantial national effort which calls for practically doubling in Fiscal 1963 the amount of money spent on solid technology this year.

The full House Science and Astronautics Committee will take note of the Defense Department's solid research in its report to accompany the NASA Fiscal 1963 authorization bill. The committee, although not recommending additional money for solids is expected to direct NASA to ask for additional funds if the Defense Department's program does not proceed at a fast enough pace.

Propulsion Funds

NASA is asking for $7.9 million for solid and $163.1 million for liquid propulsion research in Fiscal 1963. Rep. David S. King (D-Utah) has been at the forefront of those on the House space committee contending this represents far from a balanced solid-liquid program. But Thomas F. Dixon, NASA acting director of advanced research and technology, counters that liquid engines are further developed and consequently deserve more emphasis (AW Mar. 19, p. 38).

Dixon in private conferences with committee members, also cited the following figures in an attempt to show that the two types of propulsion programs were nearly in balance when military research was counted:

LARGE SOLID PROPULSION FUNDING

	Fiscal Year ($ in millions) 1962	1963
120-in. development	14.4	7.8
156-in. development	12.0	20.0
246-in. demonstration	10.0	20.0
General advanced technology		
Air Force	13.0	
NASA	3.1	8.0
Vehicle mission studies	0.5	5.0
Facilities	12.0	13.0
Advanced propellants, ARPA	17.3	20.0
Total	$82.4	$158.8
—If required		

Dr. Harold W. Ritchey, vice president of Thiokol Chemical Corp., last week told the subcommittee the U.S. has the technology in solid propulsion "for attaining high thrust that is very far superior to any other country in the world."

"I think it is a shame we are not using this," Dr. Ritchey said.

Georgia Site Studied

He said it would cost $59.8 million for his company to complete a two-year development program which would culminate in the static firing of a 240-in. solid booster of flight weight. He said planning for such a development program has led the company to choose a site in southeast Georgia which has access to deep water.

In 42 months Ritchey said, Thiokol would be able to cluster four large solids providing 20 million pounds of thrust.

"I am certain that the solid booster for the first stage application to Nova could be furnished ready for flight before 1967," he said.

As to the upper limits of solids, he said they probably could provide up to 50 million pounds of thrust.

More Contractors Invited to Bid on MMRBM

Air Force Systems Command was scheduled to mail invitations late last week to prospective bidders in five of the six weapon system categories for development of the mobile medium-range ballistic missile (MMRBM). Time for response may be as little as four to five weeks.

Contracts will cover a several-month "program definition phase" before competitors are narrowed down for actual development (AW Apr. 2, p. 22). Air Force has little more than a million dollars with which to fund work through June 30. Three study contracts for the sixth category—guidance—are now outstanding. Those invited to bid in the other categories are:

- Integration, assembly and checkout contractors: Bendix, Ling-Temco-Vought, General Electric, Martin, Hamilton Standard, Chrysler, Boeing, Raytheon, General Motors, North American, Lockheed, McDonnell, Grumman, Republic Aviation, Hughes, Northrop, Douglas, General Dynamics, Western Electric, Space Technology Laboratories.
- Propulsion contractors: Aerojet, Atlantic Research, Hercules Powder, Rocketdyne, Lockheed, Thiokol, United Technology Corp.
- Command and control contractors: Bendix, Airborne Instruments Laboratory, Collins, Avco, Cook Electric, Burroughs, Fairchild, Aeronutronic, GE, Electronic Communications, General Motors, General Telephone, General Dynamics, General Precision, Hughes, IBM, Hayes Aircraft, Itek, Space Recovery Systems, ITT, Lockheed, Litton, Ling-Temco-Vought, Magnavox, Minneapolis-Honeywell, Martin, National Company, Inc., Philco, Vitro, STL, Siegler, Sperry Rand, Western Electric, Westinghouse, Westinghouse Air Brake, Raytheon, Kollsman.
- Re-entry system contractors: McDonnell, Chrysler, Avco, GE, Aeronutronic, Lockheed, Martin, Studebaker-Packard, Aerojet, Bendix, Boeing, Douglas, North American, General Dynamics, Hughes, Ling-Temco-Vought, Northrop.
- Transporter-launcher contractors: Beech, Bendix, Boeing, American Machine & Foundry, Budd, Douglas, Chrysler, Food Machinery, Aeronutronic, FWD Corp., General Dynamics, Fruehauf, GE, Goodyear, General Motors, Hughes, Ling-Temco-Vought, Le Tourneau-Westinghouse, Lockheed, Mack Trucks, Martin, Northrop-North American, Solar, Thiokol, Sperry Rand, STL, Universal Match, Hamilton Standard, Allis-Chalmers, Studebaker-Packard, U.S. Steel.

Congress to Probe Range Management

Washington—Air Force-National Aeronautics and Space Administration friction over the management of the Atlantic Missile Range has prompted a House Science and Astronautics subcommittee investigation.

Basic complaint of the space agency officials at the Atlantic Missile Range is that they must abide by detailed and often changing Air Force housekeeping regulations.

The House Manned Space Flight subcommittee has submitted 28 questions to the Defense Department about AMR management.

Questions cover safety hazard criteria, siting of USAF Titan 3 launch pads, and apportionment of the cost of expanding the range.

One question asks why NASA should not manage its own facilities at AMR so the space agency would have "the same operational flexibility that the Air Force enjoys at both White Sands National Missile Range and the Pacific National Missile Range."

Profits Probe Focuses on Nike Program

Washington—Public hearings into charges of excessive profits on weapon systems contracts, which are likely to produce changes in defense procurement ranging from contract awards through the renegotiation process, were begun last week by the Senate Permanent Investigating Subcommittee. Focus of the first hearings was on the profits made by Douglas Aircraft Co. and Western Electric Co. on Nike missile launcher loaders produced by the Consolidated Western Steel Division of U. S. Steel Corp.

The announced target of the subcommittee, headed by Sen. John McClellan (D-Ark.), is "profits on profits" in weapon systems contracting and subcontracting. This will lead into other questions, including the freezing of designs as early as possible in a development program and the "break-out" of big contracts for competitive procurement. Tentatively, the final witnesses before the subcommittee will be representatives of the Renegotiation Board—to find out what the board has done about recouping whatever excessive profits are disclosed by the hearings.

After a thorough consideration of the Nike program, the subcommittee will proceed to the Atlas and Bomarc programs (AW Mar. 26, p. 24).

At the outset last week, the subcommittee staff presented statistics which showed that both Western Electric, the prime contractor, and Douglas, the first-tier subcontractor, made more profits on the launcher loaders than the producer—Western Electric over $9.8 million and Douglas over $10.3 million. During the period, 1951-59—which covered production for Nike-Ajax and Nike-Hercules—the profits of Consolidated Western Steel, the producer, amounted to $9.3 million.

Robert Dunne, assistant subcommittee counsel, reported that the Douglas profit included a profit on Consolidated's profit. Western Electric's profit, in turn, he said, included a profit on Douglas' profit, which included Douglas' profit on Consolidated's profit.

Donald Douglas, Jr., president of Douglas Aircraft Co., contends that his company's earnings are distorted because of "arithmetical manipulations," in which a normal 5-6% fee is increased 20-40 times "without actually increasing one whit the number of dollars earned." He said the figures presented were "startling due to the sheer magnitude of percentage. They do look large compared to the economic framework in which all of us are used to working, namely a percent earnings of total cost."

A company's earnings, he said, should be measured as a percentage of the total costs of doing the job—labor, materials, overhead, subcontracts, etc." He said the company's total profit after taxes was 1.5%.

Consolidated's costs—production and general and administrative overhead—totaled $146 million. "On this cost," McClellan said, "we paid a total $29.4 million in profits—or about 20%."

During questioning of the first industry witness, Milton Karr, chief engineer of Consolidated, the subcommittee tried to develop that Douglas made a relatively minor contribution to the launcher loader program and that the U. S. Steel subsidiary is a favored Douglas customer.

Karr reported that on Nike-Ajax, Douglas did submit detailed specifications to Consolidated, but that on Nike-Hercules, Consolidated drew up the detailed engineering specifications. In the Nike-Hercules program, Douglas gave supervision of "a general nature" including "guidance during design," performed inspection and quality control functions, and "coordinated the whole effort," he said.

Karr maintained that were Douglas eliminated as a subcontractor "Western Electric would have had to perform the same services that Douglas did."

Unanswered Question

McClellan's unanswered question was "If Douglas did all the things you say it did, what did Western Electric do?" Western Electric was eliminated and Douglas made the prime contractor for Nike launcher loaders in 1957. Douglas subsequently let launcher loader subcontracts to Consolidated totalling $81 million—in addition to the $155 million let while Western Electric was still in the program.

During the launcher loader production period, which ended in April, 1961, Consolidated had approximately 1,000 employes, including 150 to 180 inspectors working on the program, according to Karr. He said Douglas maintained eight to 12 inspectors at the Consolidated plant, Western Electric maintained two to five inspectors, and the Army, two to four inspectors. Acceptance was by the Army inspectors, and the launcher loaders were then shipped directly from the Consolidated plant to various Army operational locations.

Jerome Adlerman, subcommittee counsel, commented to Karr that "as long as Douglas is a prime contractor, you are going to be a subcontractor" and that "if Nike-Zeus goes into production, you are going to be a subcontractor." Karr reported that he knew of only "two or three" firms in the 11 western states that had the capability to produce the launcher loaders and whom Douglas could have called into competition. He named the Sunnyvale plant of Westinghouse Electric Co. and the San Francisco plant of Food Machinery & Chemicals Corp. Karr said he was uninformed as to the capabilities of plants outside the western area.

McClellan's Statement

In his formal opening statement, McClellan, after noting the excessive profits investigations which followed World War I and World War 2, observed:

"Our inquiry at this time is directed to procurement practices and systems and to the profits that accrue under such systems. We desire to ascertain whether present procurement systems result in the pyramiding of profits and costs by the taking of profits on tiers of subcontracts.

"It is expected that these studies will result in constructive changes of procurement practices. . . . At the close of these hearings the testimony will be carefully evaluated by the subcommittee with a view to determine if remedial legislation is required to eliminate unnecessary costs and profits."

Republic Will Develop Project Fire Vehicles

Washington—Republic Aviation Corp. has won a $5 million contract to develop and build two Project Fire spacecraft for use in obtaining re-entry data to be applied to design of manned and unmanned spacecraft.

The National Aeronautics and Space Administration project is directed by Langley Research Center. It involves launching the Fire package by an Atlas D booster and then driving the payload back into the atmosphere with a second stage Hercules-Allegany Ballistics Laboratory Antares rocket. Re-entry velocity will be nearly 37,000 fps.

Chance Vought Astronautics will modify the Antares stage for adaptation to the Atlas and for spin-up capability.

The Fire payload will weigh about 200 lb. It will be boosted to a 750-mi. altitude by the Atlas, and then nose over. At 150-mi. apogee, the Antares stage will ignite and ram the package down into the atmosphere.

The two flights are scheduled three months apart next summer and fall. Republic was selected prime contractor for the project over eight companies which submitted bids Mar. 12 (AW Mar. 19, p. 39).

Navy Considers Polaris Follow-on; USAF to Buy Nudets Hardware

Washington—Navy is considering developing a follow on to its Polaris A 3 missile and the Air Force plans to spend $184 million over the next two years on its nuclear detection system (Nudets) according to testimony released by the House Appropriations Defense Subcommittee last week

Rear Adm I J Galantin Navy's director of special projects told the committee there are continuing studies "to see whether there is a need for an A-4 missile"

The Lockheed Polaris A-3 is to have a range of 2,500 mi and will undergo flight tests soon Adm Galantin said the next missile, if it is developed, would have longer range, "a bigger bang or perhaps even more accuracy" Lockheed is studying an advanced A 3, now designated A-3A (AW Apr 2, p 23)

Of the $380 million requested by Adm Galantin's office for research and development for Fiscal 1963, $271 million is earmarked for the A 3 missile

Air Force is requesting $3 million for Fiscal 1963 to start procurement of Nudets equipment which would detect and assess nuclear damage to U S targets remotely The system will consist of 52 sensor sites, eight regional data processing centers and seven readout locations USAF Maj Gen R R Holzapple, assistant deputy chief of staff for systems and logistics said the Air Force will request the remainder of the total cost of $184 million in Fiscal 1964 He said the annual operating costs of Nudets will be about $2 8 million

Other major points disclosed in the House subcommittee hearings and in statements filed with the Senate Defense Appropriations Subcommittee

• **Grumman Mohawk AO-1,** Army has spent $240 million on the aircraft with $43 million of that amount going for research and development But it will not spend any Fiscal 1963 monies on the Mohawk and may not be allowed by Defense Department to buy more in Fiscal 1964, either

• **TFX (F-111A),** Air Force wants $115 6 million in Fiscal 1963 for the "orderly development" of the Air Force Navy fighter This amount will not include the 'peculiar' requirements of the Navy, the Air Force said.

• **Lockheed C-141,** USAF Lt Gen James Ferguson, deputy chief of staff for research and technology, said development is on schedule with a flight test scheduled for December, 1963 and delivery of the first operational unit in June 1965 He said contract negotiations for developing the five aircraft would be completed by June and said negotiations call for a clause requiring Lockheed to pay some of the development costs through commercial sales

• **General Dynamics Redeye** Army said technical problems stemmed from its decision to pursue one engineering approach in developing the missile rather than pay for alternatives

• **McDonnell F4H** Vice Adm R B Pirie deputy chief of naval operations for air, said he is waiting to see the changes USAF makes in the aircraft to determine if the modified version will fulfill Marine Corps reconnaissance requirements If so, Adm Pirie said the Marines would use the USAF version Rear Adm P D Stroop chief of the bureau of naval weapons said USAF has agreed in writing to accept 29 aircraft as designed for the Navy before embarking on the modification program

Satellite Detection Radar

Washington—Bendix Corp's Radio Division will develop and test a phased array radar for long range detection and tracking of numbers of satellites under a contract to Air Force Systems Command's Rome Air Development Center The radar is an outgrowth of Esar (Electronically Steerable Array Radar), which Bendix developed for RADC and Defense Department's Advanced Research Projects Agency (AW Feb 5, p. 28)

News Digest

Air Force Systems Command will create a seventh division— research and technology—to be headed by Col Joseph M Silk and based at headquarters at Andrews AFB, Md Designed to strengthen the AFSC in-house laboratory structure, it will plan and manage basic and applied research and advanced technology

Bidders conference for firms invited to compete for the Nova vehicle study contract will be held Apr 10 at the Twickenham Hotel Huntsville Ala Proposals will be due Apr 26 and two or more contracts let late next month

Industrialist Curt Nicolin is stepping down as interim president of Scandinavian Airlines System after a nine month tenure to be succeeded by his former deputy at Asea, a major Swedish electronics firm New president, effective Apr 27, is Karl Nilsson who served as deputy president of Asea during Nicolin's tenure with SAS

Portable Radar Display

Portable, eye level radar display, called Electrocular has miniature cathode ray tube mounted on headset (left) Screen display is projected onto operator's viewing eyepiece superimposed on external view The display can be focused to appear to be 8 ft in diameter when the operator's eyes are focused at a distance of 20 ft The new device, developed by Hughes Aircraft Co weighs only 30 oz and has an operating brightness of at least 25 foot-lamberts the company says

Republic Aviation Corp production workers went on strike last week in a dispute over supplemental benefits including severance pay demands growing out of production cutbacks for the F 105 Thunderchief Most of the 9,000 striking workers are members of IAM Lodge 1987

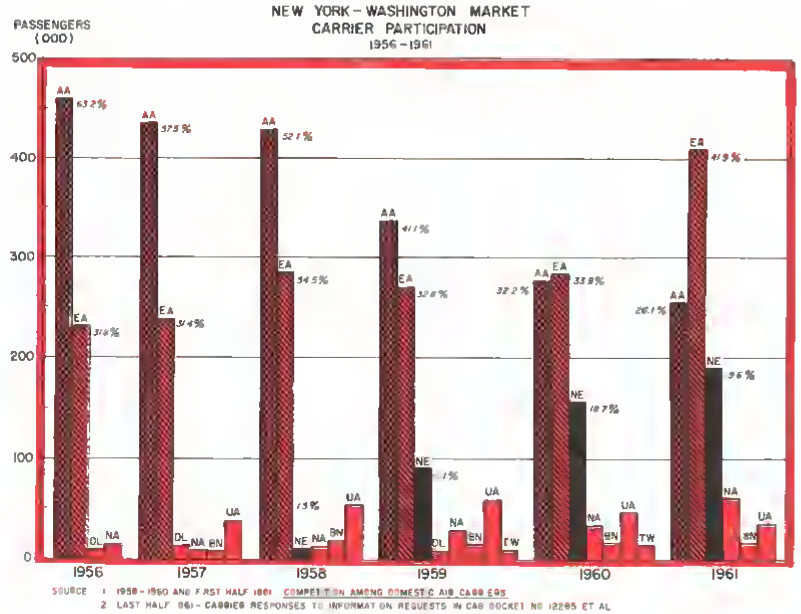
Intercept rocket to be used in test firings in support of ARPAT (Advanced Research Projects Agency Terminal) re-entry tests over PMR will be a guided three-stage configuration and special payload combination will be assembled from stages supplied by Hughes Aircraft and Aerolab Development Co under subcontracts to Raytheon Co

MATS visualizes a military supersonic transport with a normal operational range of 4,000 naut mi at speeds between Mach 2 4-3 and cruise capability at 70,000 ft, according to Lt Gen J W Kelly MATS commander, during congressional testimony

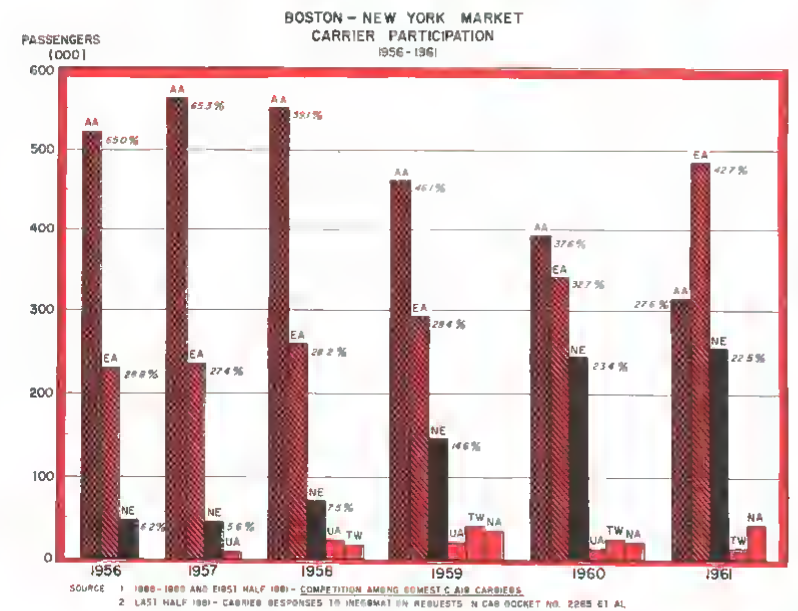
Avco's Research and Advanced Development Division is conducting a six month target discrimination study on the Nike Zeus anti missile system under a contract to Bell Telephone Labs

Parliamentary pressures to increase the size of Royal Air Force order for 10 Short Belfast turboprop transports is growing more intense R A Butler, home secretary has been told Short Brothers and Harland will be in grave financial difficulty unless government decision to order more Belfasts is made

Herbert Scoville, Jr, has been promoted to a new post of deputy director for research in the Central Intelligence Agency He was formerly in charge of CIA's scientific section



SOURCE 1 1956 – 1960 AND FIRST HALF 1961 COMPETITION AMONG DOMESTIC AIR CARRIERS
2 LAST HALF 1961 – CARRIER RESPONSES TO INFORMATION REQUESTS IN CAB DOCKET NO 12285 ET AL



SOURCE 1 1956 – 1960 AND FIRST HALF 1961 – COMPETITION AMONG DOMESTIC AIR CARRIERS
2 LAST HALF 1961 – CARRIER RESPONSES TO INFORMATION REQUESTS IN CAB DOCKET NO. 2285 ET AL

Shuttle Provides Big Competitive Boost

Eastern's successful experiment is typical of new methods used in fight for airline traffic.

By L. L. Doty

Washington—U. S. airlines, embroiled in a competitive battle for traffic, have been forced into adopting new sales and operating techniques that keep each carrier jockeying for a dominant position in high density traffic markets.

Latest figures released by Eastern Air Lines showing results of its Air Shuttle service, (see charts) which has given it a commanding position in the Boston-New York-Washington market, indicate that imaginative merchandising of airplane seats has suddenly become the main competitive device in the airlines' drive for business. As a result, chances are strong that Eastern's recently acquired lead in this market will soon be challenged by other new sales weapons and promotional tactics.

The merchandising innovations developing in the Boston-New York-Washington market have penetrated few other areas in the U. S. airline complex. In most cases, basic competition, in its unrefined form, has kept most air travel markets flexible. Novel merchandising methods, in the past, have seldom been the reason for a carrier's first-place position in terms of the number of passengers handled.

In some markets, one airline retains a commanding rank because of its strong historic identity with a certain market. Aircraft equipment alone often determines which carrier will dominate. At times, markets are subject to periodic regrouping of airline services because of changes in operating philosophy.

Whatever the reason, no airline can control any market unless it offers travelers these three basic ingredients: convenient schedule frequency, modern equipment and high standards of service. By blanketing competitors with a steady stream of flight schedules with new aircraft, many carriers have held a long term top standing in a number of major markets.

This is why United Air Lines has retained an over powering position in the Los Angeles-San Francisco-Seattle markets, why TWA consistently controls the New York-St. Louis market (see charts), why Delta leads in the New York-Atlanta market. The trite "give the customer what he wants" appears to be particularly applicable to the airline industry.

How important fares are in capturing traffic from competing airlines or in the development of new business has not been fully determined. It now appears, however, that Washington-New York-Boston market may become a test case.

In these high-density traffic markets—Boston-New York is the nation's most heavily traveled air route and New York-Washington ranks fifth—all the basic elements of airline competition are being brought into play in one of the hottest competitive fights in airline history: high frequency of schedules, low fares, minimum of service versus a high standard of service, all coupled with a series of innovations that have created a new concept of airline service, probably the first since the introduction of air coach in 1948.

In all three markets—New York-Boston, New York-Washington and Boston-Washington—American Airlines (see charts), until 1958-59, was the dominant carrier. Originally, Eastern was its sole competitor on all routes. Northeast competed only on the Boston-New York route.

Since 1956, competition has increased steadily so that today there are nine airlines serving the New York-Boston route, 11 on the New York-Washington route. So far, the newcomers have made little impact in any of the three markets.

Northeast began making the first inroads on American's strong grip on the three routes with the introduction of the Vickers turboprop Viscount, later with the inauguration of hourly commuter service. By the end of 1961, Northeast, operating eight non-stop flights daily between Washington and Boston, had captured 7.64% of this market. Its share of traffic on the other two routes rose steadily.

Northeast operated its commuter flights at first-class fares. To counter Northeast's success American introduced its "personalized express" service using Lockheed Electra transports with a coach/first class configuration.

In 1961, Eastern launched its highly-popular Air Shuttle service. The low-fare, no reservations system caught on immediately and the airline skyrocketed to the top position in the New York-Washington and New York-Boston markets. And with the start of the nonstop Washington-Boston Air Shuttle service earlier this year, it is already cutting into its competitors' share of traffic.

Northeast Airlines traffic volume between New York and Boston and between New York and Washington has declined so far this year. However, on Northeast's non-stop Boston-Washington service, traffic continued to gain during the first two months of 1962. Although the full impact of Eastern's Air Shuttle on this route has not yet been fully felt, American is feeling the competitive pinch on flights scheduled at off-peak hours.

Results of Eastern's Air Shuttle during the first two months of 1962 are impressive. Total air traffic between the three cities has increased 52% over the same period last year. During January and February 1961, before Air Shuttle service began, the combined market was 254,000 passengers. In the same months

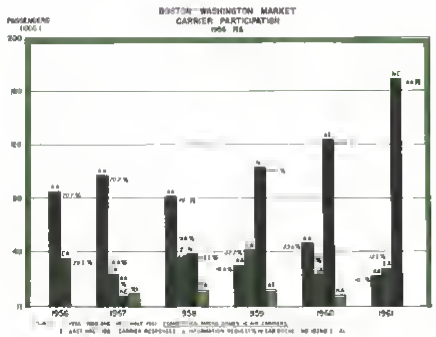
Mach 3 SST De-emphasis

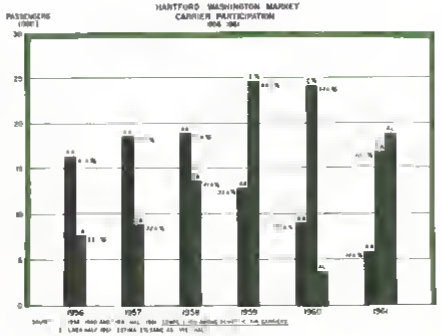
New York—U. S. supersonic transport program is open to approaches other than Mach 3, to delta or variable sweep wing concepts and to steel or titanium structures in skin-stringer combinations, honeycomb sandwich or multi-wall, FAA Administrator N. E. Halaby told the Society of Automotive Engineers.

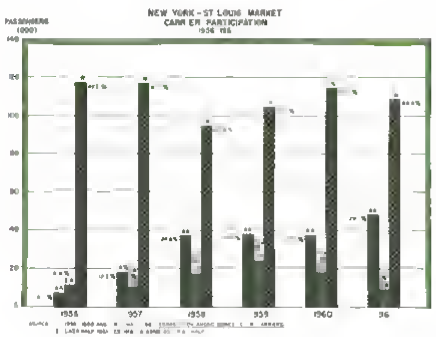
More than half the $11 million FAA will spend in Fiscal 1962 will be in the propulsion area, he said, to investigate various concepts for a supersonic cruise engine that will be reliable and efficient at Mach .85, Mach 2 and Mach 3.

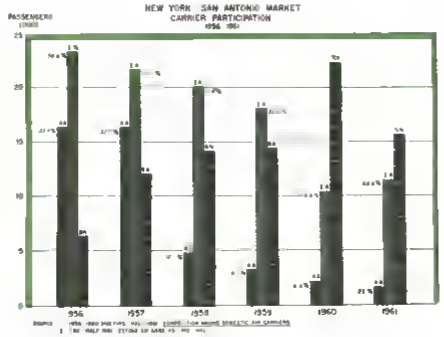
Despite strong U. S. favor for Mach 3, Halaby said: "We want a flexible airplane that will grow in step with requirements . . . capable of operating economically in both domestic and international operations." A $3.4 billion supersonic transport market is well worth going after, Halaby said, but it will cost at least $400 million to fly a few prototypes—perhaps twice that if the U. S. reaches immediately for Mach 3.

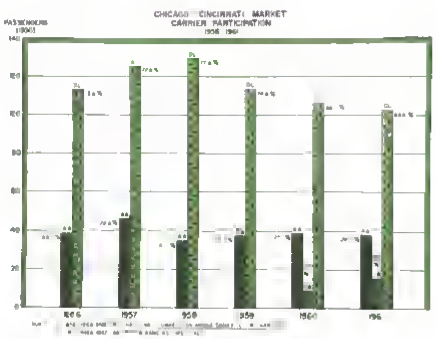
U. S. supersonic transport may well be second to Russia's Halaby said. Russia is modifying a military airplane—probably Bounder—for its propaganda value as a first supersonic transport, he said, and also is developing an airplane specifically as a supersonic transport for Aeroflot.

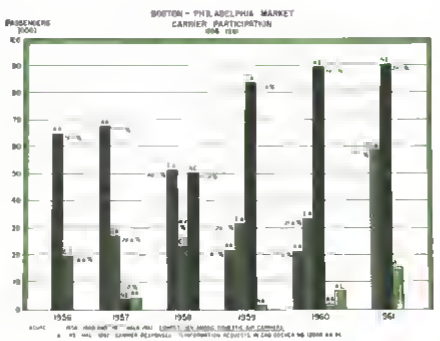












this year, it grew to 380,000 passengers.

In the comparative two-month period Eastern's traffic between New York and Boston and Washington, grew from 71,000 to 242,000. Of this amount, 70% has used Air Shuttle. Surveys show that one out of every 10 Air Shuttle passengers had never been on an airplane before, and 25% were in their early 20s or over 60 years of age. Originally 70% of Air Shuttle users were businessmen, but this percentage is dropping.

Eastern's over-all Air Shuttle load factor is currently about 55% with breakeven load factor estimated at 43%.

A total of 25 complete flight crews are assigned to this operation. Sixteen Lockheed 1049G Constellations converted to 95 seats, are used on the Washington-New York and New York-Boston shuttles. Five Douglas DC-7Bs also with 95 seats, are operated on the Boston-Washington Air-Shuttle. On Apr. 29, the service will be expanded to include Newark in the Air Shuttle.

Eastern says it is now convinced that the Air Shuttle could be operated at a profit even with non-depreciated equipment. American has stated that, if the proposed merger with Eastern materializes, the combined company will operate the Air Shuttle service with Lockheed Electra equipment, with only a token service in first-class configuration.

So far, no real attempt has been made to match Eastern's low Air Shuttle fare, although Northeast does offer a no reservations fare equal to Eastern's on its regular flights. Such passengers are treated on a stand-by basis without the guarantee that they will be accommodated on any given flight as Eastern does on its Air Shuttle.

In the long-haul markets, fares have been used as a competitive device, but the continuing drive of several major airlines for higher fares and a closing of the gap between first class and coach fares generally has discouraged expansion of the promotional fare principle. Continental Air Lines, however, has announced that it is determined to experiment with an excursion fare on the Chicago-Los Angeles route.

In the long-haul Florida market Eastern has again adopted the low fare theory to expand its traffic volume, with the introduction of Air Bus service which requires a reservation but is without the frills of standard service. Here are the carrier's load factor improvements in February, compared with the same month last year, which it attributes to Air Bus:

- **On the Pittsburgh-Florida** route, northbound load factors were 63.8% against 46.5%, and southbound load factors were 78.3% against 53.1%.
- **Cleveland-Florida** load factor was 82.55% versus 55.3% on southbound flights and load factor on northbound flights was 71.7% versus 44%.
- **St. Louis-Florida** load factors were 75% versus 51% southbound and 71.6% versus 50.3% northbound.

One factor which appears to be changing the relative standings of various carriers in some markets is the move by large carriers from short-haul markets to long-haul markets as the use of jet equipment expands. In such cases, local service carriers are the beneficiaries and are gaining new route mileage in high density markets that they might have otherwise been denied.

In recent years it has been the policy of both American and Eastern to withdraw from certain short haul markets which can be served more adequately by local service airlines. In addition the trend among a number of large carriers has been to concentrate sales efforts and flight schedules in the high density long-haul markets where large turbojet aircraft can be flown profitably without economic operating sacrifices.

The gradual reduction of service in the Hartford-Washington market (see charts) which is slowly but steadily expanding in passenger volume, enabled Allegheny Airlines to climb from a 12.8% share of this market in 1960 to an estimated 46% in 1961. Allegheny also topped both Eastern and American in passengers carried in the Hartford-Washington market in 1961.

Route philosophy of both Braniff and Delta differs from that of the two larger carriers with respect to short haul routes. Delta holds that it will profit by concentrating its attention on any high density market despite the length of haul.

Delta has also profited by placing piston-engine aircraft in short-haul markets with schedules timed to the convenience of passengers. Turbojet aircraft, serving long haul markets, at peak travel times could operate in the shorter haul markets only at odd hours of the day or night.

Delta's theory on the high-density, short-haul markets has made it the dominant carrier in the Chicago-Cincinnati market (see charts).

Equipment has played a major part in determining which carrier will dominate a market. When Capital Airlines was merged into United introduced Vickers Viscounts in the Chicago-Washington route in 1955 it surprised the entire industry during the ensuing years by becoming the leading carrier in this market.

Delta dominated the Chicago-Miami market immediately following World War 2 until its Douglas DC-4 equipment was outpaced by Eastern's new Lockheed Constellations. Delta mixed shoulder-to-shoulder with Eastern when it introduced Douglas DC-6Bs on the route; pitted Eastern with its DC-7s and took a commanding lead when it beat Eastern in the introduction of jets on the route.

TWA has maintained its hold on the New York-St. Louis market by its close identity to St. Louis and by consistently retaining the three ingredients of base competition in this service. At one time, Eastern attempted to capture some of TWA's share in the market by accelerating its schedule frequency, but withdrew when the maneuver failed to produce any substantial increase in revenue passenger miles. This occurred before Eastern had adopted its current merchandising programs.

Soviet An-24 Planform Shown

Planform and underbody shape of Russian An-24 transport show relationship of this 32-40 passenger aircraft to larger An-10 series also designed by Oleg K. Antonov. Plane is powered by two Ivchenko turboprop engines which drive four-bladed variable-pitch propellers. Russian sources list cruise speed of 310 mph. and range of 1,240 mi. Takeoff distance from dirt runway is claimed to be 1,475 ft., with landing distance from 1,150 to 1,310 ft.

Kennedy Urges Merger Guidance By U.S., Lower Fares and Subsidy

By Robert H. Cook

Washington—President John F. Kennedy emphasized a need for federal development of airline merger criteria, along with lower air fares and extensive subsidy reductions as vital areas of Administration concern last week in his long-awaited transportation message to Congress.

Criticizing the "chaotic patchwork of inconsistent and often obsolete legislation and regulation" which governs the national transportation system, the Chief Executive outlined a program for the most efficient use of all forms of public transportation with "less federal regulation and subsidization."

The President, reflecting the mounting volume of merger discussions in both the railroad and airline industry underscored the Administration's responsibility to recommend more specific merger guidelines than are now available and more detailed procedures for their application.

In line with this philosophy, President Kennedy stated that he has directed the formation of a special interagency group to formulate general Administration policies on mergers for each segment of the transportation industry, and to aid the Justice Department in presenting the government's position on each merger application before various regulatory agencies.

Group Membership

The group will include agency representatives designated by the Attorney General, the Secretary of Commerce, the Secretary of Labor, the chairman of the Council of Economic Advisers and the heads of other agencies involved in the merger case. Under the chairmanship of a Commerce Department official, the group will examine each merger proposal on the primary basis of retaining effective competition, providing an economical operation which could still furnish economical, efficient and adequate service to the public and aiding workers directly affected by a merger. The group may also apply any other criteria which it may subsequently develop, he added.

To stimulate travel, passenger fares should be lowered by limiting federal powers to fix uniform minimum rates for passenger travel, the President said. Congress should pass legislation which would eventually limit control of these rates to the establishment of maximum rates only.

Kennedy noted that it might be best to apply such a program to airlines on a gradual or temporary basis under existing authority. "The traveling public, like the commercial shipper, is also uninterested in paying higher rates to subsidize weak segments of the transportation industry," he said. "Chronic overcapacity and deficits can be ended in the long run only in an industry made fit, lean and progressive by vigorous competition and innovation." In implementing this program, he cautioned that Congress should be alert for any violations of existing laws against monopoly and "predatory trade practices."

Kennedy called for a broad scale reduction on airline subsidy payments as a means of achieving a "better balance of federal promotional programs" and endorsed Civil Aeronautics Board legislation which would make domestic trunk carriers ineligible for subsidies in the future. He pointed out that this group of airlines provides more passenger miles of transportation than any of the other common carriers, and while they have experienced "temporary overcapacity" and financial losses still have "bright prospects" for long run growth and prosperity.

Helicopter Subsidy Cut

Subsidy payments for the three certificated helicopter services should also be terminated, he said, in line with recommendations made last year by the appropriations committees of Congress, which have asked the CAB for a schedule to eventually eliminate these payments.

The President said this same principle should be extended to the local service airlines and that he has already asked CAB to develop, by June 30, 1963, a "step by step program with specific annual targets" to assure a sharp reduction in this subsidy.

"Rigorous enforcement" of the Board's "use it or lose it" policy, refinement of the new class mail rate subsidy formula and the development of single airports to serve adjacent facilities, or regional airports, would aid in eventually eliminating this subsidy expense, he said.

Citing the "inequities" contained in the present system of transportation taxes, Kennedy called for repeal of the 10% transportation tax and re-emphasized the need for an extensive system of user charges to cover the federal cost of operating and maintaining the federal airways system.

The transportation tax, a "vestige of World War 2 and the Korean War," has discriminated against public transportation in favor of auto users, he said, and should be repealed to equalize competition between intercity railroad and bus transportation, "and to clear the way for an equitable system of user charges for aviation."

Under the user charge system, commercial airlines would continue to pay the present two cents per gallon on gasoline, with the same tax rate expanded to include jet fuels. In addition, a 5% tax would be levied on airline tickets and airfreight waybills. These recommendations, if approved, would not become effective until Jan. 1, 1963, to permit a CAB review of any carrier applications for tariff revisions necessary to offset fuel taxes.

Fuel Tax

Since general aviation operations do not include individually ticketed services or freight operations, these services would pay a fuel tax of three cents per gallon as a "minimal step" towards offsetting the federal cost, he said.

The President noted that all of the suggested taxes will recover only about one half of the estimated $500 million annual operating expense of the federal airways system, and that the 10% passenger tax should not be abandoned until the complete user charge system is in force for all segments of civil aviation.

Reporting on the problems of international aviation, President Kennedy said that a study established at his direction last July should be ready by this summer (AW Apr. 2, p. 28). An interdepartmental committee, headed by the administrator of the Federal Aviation Agency, is conducting the study, with representatives of the State, Defense, and Commerce departments, the Civil Aeronautics Board and the Budget Bureau. The Budget Bureau is also studying the role of various government agencies in the field of international aviation, and once these two studies are completed and analyzed, an Administration policy on international civil aviation will be formulated, he said.

Other Points

In other segments of the report, President Kennedy formed a need for federal development of policies to aid the collective bargaining processes in labor disputes.

Such policies should aid in encouraging increased productivity and should recognize the job equities affected by technological change.

The investment in international transportation, he said, should be geared to the requirements of our peacetime international trade and travel, while providing incentives to users that will channel traffic to the form of transportation that provides a desirable service at the lowest total cost.

Northeast Urges Speed in Control Case

Washington—Hughes Tool Company Northeast Airlines Control Case hearing must be accelerated or "we're not going to have anything to have a hearing about," Northeast attorney John C. McInerney told a Civil Aeronautics Board examiner last week.

Rembrandt P. Lane, Jr., vice president-finance and treasurer for Northeast, told the examiner that losses for the first quarter of 1962 were greater than anticipated. The resulting lack of available cash has caused the airline to default on its Mar. 31 principal payments on equipment-secured debts—$185,000 to a group of lending banks under a 1955 credit arrangement and $395,000 to General Electric Co. under a jet engine lease agreement. On May 1, another payment of $185,000 comes due.

Lane's Testimony

Lane testified that on Apr. 15, a $190,000 payment to Vickers Aviation Ltd. for Northeast's Viscounts and a $300,000 payment to General Dynamics Corp. for the airline's Convair 880's are due. Also due on the same date is the first of three equal payments to Chase Manhattan Bank for the $1 million interim assistance loaned to the airline and secured by Hughes Tool. Payments on all three fall due again on May 15.

Against this backdrop, Northeast's President James W. Austin told the examiner that on Mar. 29, Hughes Tool rejected Northeast's plea for additional funds. Austin said no figure was mentioned because Hughes Tool flatly refused to lend more money until the outcome of the case.

Hughes Tool has loaned Northeast $10.5 million since May, 1960 and has been guaranteeing payment of Northeast's fuel bill to Shell Oil during the present financial crisis.

Creditors' Meeting

Upon default of the Mar. 31 payments a meeting of Northeast's principal creditors—a group of banks led by Chase Manhattan, General Electric, Vickers, First National Bank of Boston, General Dynamics and Manufacturers Trust—was held in New York.

Lane, who left the CAB hearing on Monday to attend the creditors' meeting, reported on Tuesday that the creditors wanted:

- **Some indication** of the possibility of CAB's ruling by May 15 at the latest—the date by which Northeast indicated it may run out of cash unless it gets more financial help. Until then, Northeast said, it has enough money to meet immediate operating needs.
- **Hughes Tool** to give some specific indication of what it would do if CAB lets it control Northeast.
- **Northeast** to submit whatever programs it has for reducing its losses. Lane said Northeast was working on several ideas but none was complete. One involves utilization of regional airports in the area applicable on its New England system (see page 45). The move would save an estimated $1.5 million annually.

Lane said the creditors took no action at the meeting. But a default on payment to one creditor constitutes default to the others.

An defaulted payment could lead to foreclosure on equipment within 10 days by all creditors.

Florida Market

Lane said Northeast's long haul Florida market remained good throughout the first part of the first quarter but this year but declined in March. First quarter long haul profits once estimated at $3.52 million were revised to $1.29 million. The reduction could not offset the most recent short haul loss estimate of $1.99 million. The result is a system loss of $693,000.

Lane said Northeast's suspension of advertising between May and December of last year, recurring adverse publicity, the "tentative and uncertain" status of the Hughes Tool assistance offer, an increase in Eastern Air Lines' jet capacity on the Florida route, and the introduction of Eastern's Air Shuttle in the northeastern markets were the principal causes of the losses.

Austin testified that Northeast officers and certain key personnel took voluntary pay cuts from May of last year through January of this year to help offset earlier losses. He said he had informal discussions with the Air Line Pilots Assn. concerning pilot pay cuts, but no action resulted.

In a monthly letter to lending institutions late last month, Lane listed Northeast's debts over $60,000 due Feb. 28: Shell Oil, $2.63 million; Trans World Airlines, $1.30 million; J. Walter Thompson, $590,000; General Electric, $360,000; Massachusetts Port Authority, $350,000; New York Port Authority, $335,000; Vickers, $170,000; Lakewood Foods, $147,000; United Aircraft Corp., $135,000; Convair, $106,000.

Local Service Activities

Washington—Civil Aeronautics Board, in a notice of proposed rule-making, last week moved to stop local service airlines from investing in non-air transport business. Carriers have until May 7 to reply before the action becomes final.

CAB said these subsidiary activities might tend to divert the airlines' emphasis from their prime function of air transportation, for which they receive subsidy.

Senate Sets Probe Of Noise Abatement

Washington—Sen. A. S. Monroney (D-Okla.) announced last week the Senate aviation subcommittee plans to hold hearings on aircraft noise abatement procedures to determine what effect they have on airline operations and passenger safety.

Addressing a conference of the Airport Operators Council, the senator said the decision was prompted by the recent crash of an American Airlines 707 transport at Idlewild Airport and the Supreme Court decision upholding the noise damage claim of a resident near the boundary of the Greater Pittsburgh Airport (AW Mar. 12, p. 39).

Emphasizing that there can be "no compromise with safety," Monroney said that any indication that special takeoff and landing procedures under locally imposed noise abatement procedures have endangered flight safety "will not be tolerated." Corrective action which the subcommittee might recommend could include a reduction of flight schedules into congested terminal areas and their diversion into nearby airports, he said.

FAA Administrator N. E. Halaby told the group that where specific local noise problems arise, FAA is willing to change approach or landing patterns, but only if it does not make "excessive demands" on the pilot.

Initial Ruling Made In Transpacific Case

Washington—Civil Aeronautics Board Examiner William J. Madden last week found that the U.S. has no control over the operation of excess capacity by U.S. international carriers and that "no valid findings" can be made as to the effectiveness of such control by foreign governments. At the same time, Madden recommended that a route between the U.S. mainland and Honolulu and Tahiti be awarded to South Pacific Airlines.

The decision was made in the Transpacific Route Case, which was reopened to determine capacity controls with respect to service patterns recommended for Northwest and Pan American, and to consider applications of South Pacific and Pan Am for the Tahiti route.

Carvair ATL-98 Makes First Flight to Belgium

First Carvair ATL-98 car-ferry makes its initial flight to Ostend, Belgium. In foreground is special hydraulic car lift designed for the operator, Channel Air Bridge, by Little-Green Engineering Co., Manchester, England. Carvair is a Douglas DC-4 conversion (AW Sept. 4, p. 46) and will be used between Southend Airport near London, to Ostend, Calais, Basle and Geneva, starting this month. Airline has ordered 10 Carvairs, converted by Aviation Traders, Ltd., at Southend. All airplanes will bear the names of famous bridges; this aircraft was christened "Golden Gate Bridge." Aircraft has payload range of 2,160 stat. mi. and cruise speed of 200 mph.

CAB Investigates Regional Airports

Washington—Civil Aeronautics Board late last month launched the first of a series of area investigations that will eventually encompass the entire U.S. to fix the location of regional airports serving two or more communities.

CAB selected the six-state New England area as the first target for investigation.

The study is in line with a CAB-Federal Aviation Agency statement issued last May which said that many communities with small, nearby airports could get improved service with bigger aircraft operating from larger airports that are shared with one or more communities.

In establishing a plan for the investigation, CAB said it was materially assisted by the regional airport plan adopted by the New England Council on June 29. However, CAB said the present investigation would be directed at implementing only those parts of the council's plan that now seem feasible.

The council adopted the plan after a study of 45 New England airports of which 33 now receive scheduled airline service.

Of these 33 airports the council concluded that 20 could serve as regional airports.

The council's plan is intended to establish economically sound locations for regional airports that would accommodate fixed-wing aircraft likely to be operated until 1970. The plan also would establish regional airports within a reasonable ground travel time of each New England community certificated for airline service with a maximum use of existing airports.

In adopting the plan, the council established the following criteria for these airports:

- **Runway length** must not be less than 5,000 ft., corrected to sea level and capable of serving a minimum single wheel load of 40,000 lb.
- **Airports must** have all-weather capability. This would include instrument landing systems, runway lighting and control towers.
- **Ground travel** time must be no more than 60 min., unless the area has a low population density.
- **Passenger departures** per year must be at least 0.1% of the U.S. total, which, in 1959, would have been 14 per day.
- **Airport** area must have a record of a reasonable growth in potential air traffic.
- **Airports must** have facilities for housing and maintenance of aircraft and the airports must also have facilities for accommodating passengers.

CAB said while it believed the council's plan was generally reasonable, it would approach regional airport selection differently. While the council would approach the problem on the airport by airport basis, CAB said that, in its investigation, it would give primary consideration to relative traffic volumes, common interest in destinations and also airport driving times and distance.

The cities named in the investigation are Auburn/Lewiston, Bar Harbor, Houlton, Rockland and Waterville, Me., Berlin, Concord, and Laconia, New Hampshire, Newport and Rutland, Vt., Fitchburg, Lawrence and Pittsfield, Mass., and New Haven, Conn.

Final Pool Talks Set On Ground Equipment

Denver—Major trunklines hope to complete this week a ground equipment pooling agreement which they anticipate may reduce the airlines' annual capital investment costs by $1 million.

Representatives of American, Braniff, Continental, Delta, Eastern, National, Northeast, Northwest, Pan American, Trans World, United and Western airlines are scheduled to meet here to discuss the proposal.

Plans for participation by British Overseas Airways Corp., Canadian Pacific Airlines and Qantas Airways will be formulated later.

Basic terms of the agreement, urged in the past by the Civil Aeronautics Board as one means of reducing the industry's operational costs, provide that each airline will share the use of its own and members' ground equipment at various airports under a variety of use-charge formulas. Ownership of each piece of equipment would remain with the individual carrier and provisions for damage payments have been made to offset any loss resulting from use by another airline.

Each carrier would also maintain its own equipment, while the ground personnel of all members would be entitled to operate whatever equipment is needed, regardless of ownership.

Scope of the savings expected from the agreement is indicated by American Airlines' estimates that the value of its ground service equipment ranges from $60,000 at a through station to $275,000 at a major terminal such as Chicago's O'Hare.

Argosies Phosed Into RAF Tronsport Commond

First 10 Armstrong Whitworth AW 660 Argosy transports were delivered to RAF's No. 114 Squadron at Colerne, Wiltshire, and are averaging about 8 hr. daily in local and route proving flights. Squadron is the first RAF operational unit to start phasing Argosies into the Transport Command. A total of 16 has been delivered to the Aeroplane and Armaments Experimental Establishment at Boscombe Down. Transports, powered by four Rolls-Royce Dart 101 turboprops of 2,680 eshp. each, are the forerunners of 56 ordered by the Royal Air Force.

Airlines List Officers' Salaries, Expenses

Washington—Following is a list of airline officers' salaries, bonuses and indirect compensation, expenses and stock holdings for the year ending Dec. 31, 1961, as reported to the Civil Aeronautics Board.

Continental Air Lines Inc—L. B. Moeller, chairman of the board, $806 salary, 29,287 shares of common stock; R. F. Six, president and director, $78,334 salary, 6,250 shares of common stock; H. L. Lawrence, executive vice president and director, $48,333 salary, 2,100 shares of common stock (partners held in joint tenancy); H. W. Bell, Jr., vice president-personnel, $[illegible]36 salary, 400 shares of common stock; C. B. Calhoun, vice president-engineering and maintenance, $29,000 salary, 210 shares of common stock; A. Damm, vice president-finance, $35,334 salary; M. L. Davis, vice president-sales, $25,000 salary, 260 shares of common stock; O. R. Haueter, vice president-operations, $23,600 salary, 2,100 shares of common stock; M. Kramer, vice president-customer service planning, $26,500 salary, 1,147 shares common stock; E. B. Knox, vice president-customer field services, $24,806 salary; S. B. Redmond, vice president-regulatory proceedings, $22,833 salary, 743 shares of common stock; R. G. Schooling, vice president-purchasing, $20,786 salary, 272 shares of common stock; C. F. Whelan, vice president-economic planning, $26,500 salary, 200 shares of common stock; D. R. Wilson, vice president-flight, $26,500 salary, 189 shares of common stock; C. A. Burke, assistant vice president for sales, $16,801 salary; H. H. Cady, assistant vice president and treasurer, $16,333 salary, 64 shares of common stock; F. G. Colmar, assistant vice president and budget director, $15,600 salary, 63 shares of common stock; G. J. M. Bell, assistant vice president and secretary, $14,666 salary, 1,044 shares of common stock; B. King, assistant vice president-publicity, $18,333 salary, 1,000 shares of common stock; M. W. R. Meyer, assistant vice president-advertising, $16,284 salary; P. F. Kolthe, Jr., assistant secretary and director of security, $14,200 salary, five shares of common stock; L. C. Ames, director, $600 salary, 22,123 shares of common stock; A. O. Beckman, director, $100 salary, 420 shares of common stock; S. G. Cooper, director, $500 salary, 2,025 shares of common stock held jointly; F. L. Ehrman, director, $600 salary, 10,500 shares of common stock held in the name of others; W. F. Hellman, director, $400 salary, 16,035 shares of common stock held in the name of others; L. D. Henry, director, $400 salary, 200 shares of common stock; J. G. Holland, director, $300 salary, 4,024 shares of common stock; D. A. Kimball, director, $300 salary, 600 shares of common stock; J. A. Pritzlee, director, $400 salary, 16,300 shares of common stock; F. B. Rickertson, Jr., director, $400 salary, 9,050 shares of common stock; R. J. Smith, director, $450 salary, 4,05[illegible] shares of common stock; R. Steward, director, $500 salary, 100 shares of common stock; J. A. Uhl, director, $300 salary, 6,373 shares of common stock. (Continental did not furnish expense figures but will file them later.)

The following firms were paid $5,000 or more for services rendered during the year ending Dec. 31, 1961: **Cooper, Whitr & Cooper**, legal services, $33,738; **Holland & Hart**, legal services, $47,222; **Pent Marwick, Mitchell & Co.**, auditing and other services, $15,071; **J. Walter Thompson**, advertising, $2,592,328; **Charles Baller Associates**, consultants, $13,003; **McKinsey & Co., Inc.**, consultants, $8,971; **H. Gulightly**, consultants, $13,174; **C. Edwards Leasure**, legal services, $47,873; **Gibson, Dunn & Crutcher**, legal services, $12,100; **Debevoise, Plimpton & McLean**, legal services, $7,851; **Lehman Brothers**, investment services, $6,167; **Milbank Tweed Hope & Hadley**, legal services, $22,145; **Quinton Engineers, Ltd.**, engineering services, $53,775.

Delta Air Lines Inc—C. F. Woolman, president, general manager and director, $65,708 salary, $1,474 expenses, 41,196 shares of common stock; T. G. Cole, executive vice president-administration, assistant secretary and director, $41,225 salary, $508 expenses, 741 shares of common stock; C. H. Dolson, executive vice president-operations and director, $41,225 salary, $866 expenses, 1,737 shares of common stock; R. S. Maurer, vice president-legal and director, $28,645 salary, $2,003 expenses, 103 shares of common stock; W. T. Beebe, vice president-personnel, $28,846 salary, $137 expenses, 112 shares of common stock; T. M. Miller, vice president-traffic and sales, $31,480 salary, $2,074 expenses, 80 shares of common stock; E. L. Gelduhn, vice president, $24,750 salary, $3,095 expenses, 100 shares of common stock; R. Oppenheimer, controller-treasurer, $21,710 salary, $109 expenses; R. H. Wharton, assistant vice president-personnel, $19,322 salary, $22 expenses, 253 shares of common stock; C. FitzGerald, assistant treasurer, $7,750 salary, 4,236 shares of common stock; H. H. Saxon, assistant treasurer, $14,170 salary, $67 expenses; J. R. Mowell, assistant treasurer, $14,250 salary, $10 expenses; C. B. Willard, assistant vice president-operations-technical, $20,602 salary, $131 expenses, 150 shares of common stock; P. M. Pair, assistant vice president-properties, $17,709 salary, $3,641 expenses, 100 shares of common stock; C. P. Carroll, assistant vice president-sales, $17,132 salary, $1,589 expenses, 272 shares of common stock; R. W. Freeman, chairman of the board, $1,320 salary, $7,000 expenses, 8,050 shares of common stock; R. W. Conrin, director, 1,000 shares of common stock; E. B. Gress, director, $24, expenses, 1,050 shares of common stock; J. R. Longmire, director, $182 expenses, 2,500 shares of common stock, 2,109 shares of common stock held in the name of others; W. Nunnally, director, 13,000 shares of common stock; C. Potcom, director, 7,000 shares of common stock held in the name of others; E. Flynn, director, $68 expenses, 100 shares of common stock; G. M. Snellings, Jr., director, $80 expenses, 325 shares of common stock.

The following firms were paid $5,000 or more for services rendered during 1961: **Chapman, Walsh and O'Connell**, legal services, $31,359; **Arthur Andersen & Co.**, auditing services, $16,400; **Dewitch, Kerrigan and Siller**, legal services, $16,742; **Dr. Sydney Q. Jones**, professional services, $9,810; **Operations Research Corp.**, technical training, $8,988; **Poage & Neal**, legal services, $8,522; **F. J. Dillings**, legal services, $6,320; **Turner Rodgers Winn Scarlorkmail Terry**, legal services, $6,521; **Diaz Marrero**, auditing services, $6,250; **Powell Goldstein Frazer and Murphy**, legal services, $5,010; **Dr. Creil H. Pirkle**, professional services, $5,444.

SHORTLINES

► Allegheny Airlines has inaugurated an commuter service between Washington Philadelphia and Philadelphia Hartford. On the former route, commuter fare is 13% below the standard rate and 26% is reduced on the latter route.

► Austrian and U.S. representatives met in Washington last week to discuss terms and conditions of the interim bilateral air transport agreement between the two countries.

► Bonanza Air Lines will begin nonstop service between Los Angeles and Las Vegas on Apr. 29. The airline also reports it carried 316,000 revenue passengers during 1961—a 24% increase over 1960—and increased its revenue passenger miles by 25% to 79.7 million.

► Delta Air Lines will begin service between Los Angeles and San Juan, Puerto Rico via New Orleans on May 1. Flights will leave Los Angeles 6 p.m. Sundays, Wednesdays, Thursdays and Fridays and arrive San Juan 5:44 a.m. the following morning. Return flights will depart San Juan in the morning and arrive in Los Angeles Monday, Thursday, Friday and Saturday afternoons.

► Light scheduled airlines have filed with the Civil Aeronautics Board an amendment to the mutual aid agreement under which an airline whose operations are interrupted because of a labor strike could receive 25% of normal operating expenses in payments from other parties to the agreement. Previously, payments to a struck carrier were based on increased revenues which other airlines generated as a result of the strike.

► International Air Transport Assn. traffic conferences will be held May 23 at Cannes, France and Sept. 24 at Chandler, Arizona. Fares and rates to be effective in 1963 and 1964 will be negotiated at the fall conference.

► Military Air Transport Service recently awarded 15 civilian airlines a total of $9.1 million for overseas transportation of passengers and cargo for the period of February through June.

► Russia, by 1980, expects air transportation to serve half of all domestic passengers making trips between 600 and 1,200 mi. and over 80% of all passengers making trips over 1,200 mi. Long range plans contemplate a comparatively minor role for long-haul highway passenger transportation during the next 20 years.

AIRLINE OBSERVER

► House anti-trust subcommittee, which accepted without question Eastern Air Lines' projected earnings of $10 million a year (AW Apr. 2, p. 26), failed to note financial problems confronting Eastern that were contained in the estimates. Eastern's $80 million bank debt maturities amount to $20 million next year, then peak at $40 million in 1964 and return to $20 million in 1965 when the debt is retired. Deliveries of Eastern's 40 Boeing 727 transports will also reach a peak in 1964, resulting in an estimated cash deficit of $63 million. Carrier expects to have $89 million borrowing power at this time. Assuming the $40 million earnings annually do materialize, the committee's description of Eastern's powerful financial resources still seems open to debate.

► British European Airways has asked the Air Transport Licensing Board for permission to levy no-show charges on United Kingdom domestic routes beginning next November. Airline claims it is getting 150,000 "phantom" bookings a year, the majority on the London-Manchester-Glasgow route. Under the BEA plan, passengers making reservations will be given a time limit for ticket pickup. If the passenger fails to appear, he will be charged $5.60.

► Local service airline passenger traffic increased 15.4% in February over the same month in 1961. Total local service revenue passenger miles for the first two months of 1962 climbed 19% over last year's January-February total.

► Intra-European passenger traffic on scheduled airlines increased 13% during 1961 compared with the previous year, but a 19% increase in available seat miles forced load factors down to 54%, a reduction of 2.8% from 1960 levels.

► British Overseas Airways Corp. is restricting "for the time being" any further increase in services on its world-wide network. Sir Basil Smallpeice, managing director, said expansion will be limited to 6% over the next 12 months. Airline will also retire its least competitive aircraft—Douglas DC-7s and Bristol Britannias—and concentrate on use of its de Havilland Comet 4s and Boeing 707s.

► Eastern Air Lines has set up a "czar system" of top level executives to handle peak weekend problems on its route system. Three officials—one each from maintenance, flight operations and customer services—remain at Idlewild each weekend from Friday afternoon through Sunday night, to make decisions on such problems as scheduling extra crews and airplanes. System grew out of bad weather problems which called for on-the-spot decisions at high level.

► Aeroflot says timetables for twin-jet Tu-124 service have been drawn up and that the craft will definitely go into "wide use" during May. First routes will be from Moscow to Leningrad, Tallinn and Vilnius. Subsequent Tu-124 service will be from the Soviet capital to Volgograd (Stalingrad), Gorky, Kazan, Bryansk, Ulyanovsk and Rostov.

► Federal Aviation Agency has begun an evaluation to determine whether an additive that would minimize the chance of ice formation should be required in JP-4 fuel used by civil turbine-powered aircraft. The military services made such an anti-icer mandatory in JP-4 on Apr. 1. FAA has set no target date for completing its evaluation nor has it reached any conclusions as yet.

► Bell Aerosystem Co. has contracted with Federal Aviation Agency to design and build a device to convert weather teletype data into voice messages for automatic broadcasts to pilots over VOR ground stations. Specifications require that equipment is capable of recording and storing up to 30 selected incoming weather messages each up to 60 characters in length.

► Aer Lingus' plan to buy two Sud Caravelles for its European routes has been postponed. The Irish airline was unable to get government approval for the purchase.

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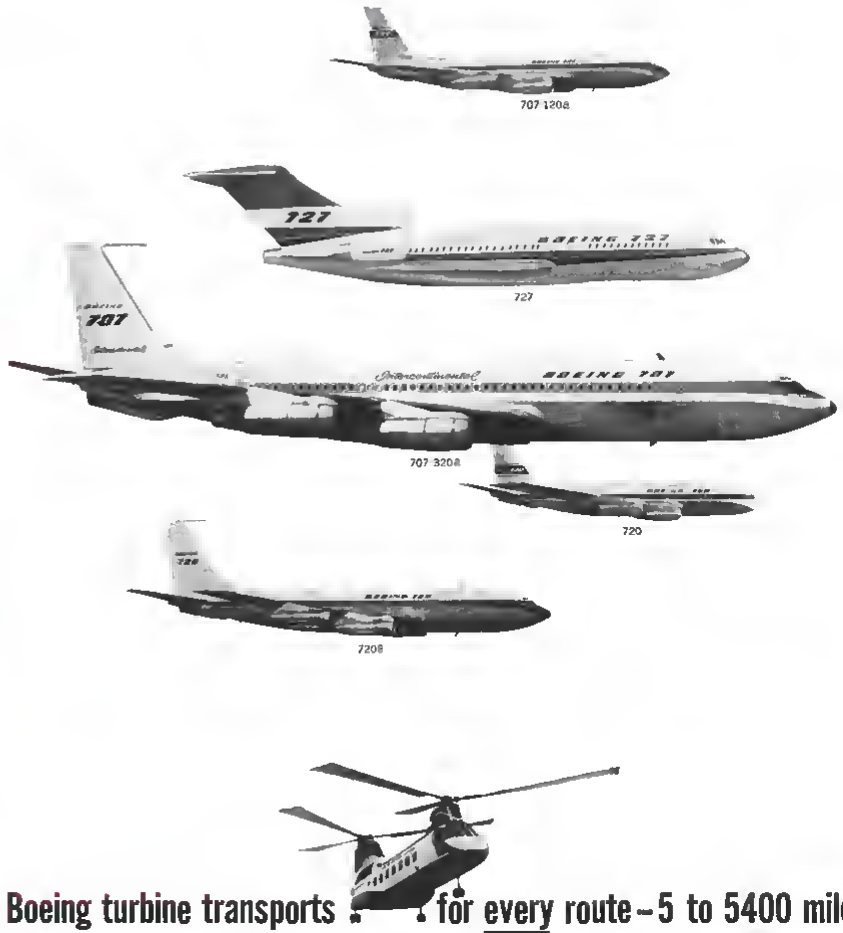
Turbine Aircraft 1961 Operating, Traffic Statistics

Type / Airline	IN SCHEDULED SERVICE: Revenue Miles (000)	Passenger Miles (000)	Passenger Load	Load Factor (%)	ALL SERVICES: Revenue Hours	Off-On Speed	Daily Util.	Fuel—Gal Per Hour
BOEING 707								
American	30,848.4	2,231,398	72.3	56	63,469	486	8:27	2,218
Braniff	3,974.2	241,874	60.9	57	8,902	468	6:06	2,635
Continental	10,296.8	544,976	52.9	46	21,746	474	11:55	2,294
Pan American	40,954.8	3,272,926	79.9	61	92,901	491	8:47	2,502
Trans World	41,902.8	2,687,768	64.1	51	87,530	480	9:08	2,395
Western	2,554.5	171,191	67.0	59	5,746	447	7:52	2,280
Delta-Interchange	128.1	13,478	105.2	88	308	416		2,709
Eastern Interchange	324.5	19,082	58.8	56	696	466		
National-Interchange	194.4	19,119	98.3	84	468	415		2,405
Northeast-Interchange	284.5	26,011	91.4	68	639	445		
707 Total	131,463.0	9,227,823	70.2	55	282,485	483	8:51	2,388
DOUGLAS DC-8								
Delta	7,094.1	585,526	82.5	69	16,190	438	7:27	2,369
Eastern	15,550.2	1,051,419	67.6	58	33,481	464	7:27	2,560
National	5,792.1	433,699	74.9	62	12,126	478	9:43	2,640
Northwest	7,439.0	434,337	58.4	52	15,413	483	8:31	2,489
Panagra	2,088.9	145,885	69.8	62	4,203	498	4:10	2,508
Pan American	25,694.9	1,510,134	58.8	49	54,512	479	7:49	2,667
Trans Caribbean	86.7	8,455	97.5	60	172	504	5:33	4,079
United	50,568.9	3,554,727	70.3	60	107,930	469	8:30	2,410
American-Interchange	373.1	35,158	94.2	83	809	461		2,401
DC-8 Total	114,687.9	7,759,340	67.7	58	244,836	470	8:01	2,505
BOEING 720								
American	25,099.7	1,731,918	69.0	67	52,632	477	7:34	2,154
Braniff	2,109.3	136,541	64.7	61	4,760	443	6:28	2,467
Eastern	2,130.6	118,467	55.6	52	4,657	457	4:51	2,217
Northwest	3,050.5	165,204	54.2	51	6,643	460	6:26	2,309
Trans World	1,260.5	67,321	53.4	48	2,639	478	5:41	2,275
United/Capitol	20,182.4	1,354,166	67.1	64	45,870	440	7:09	2,235
Western	2,589.6	186,655	72.1	61	5,648	458	6:30	2,111
Continental-Interchange	64.4	4,410	68.5	60	134	481		2,218
720 Total	56,487.0	3,764,682	66.6	63	122,983	469	7:03	2,267
CONVAIR 880								
Alaska	378.9	15,724	41.5	41	801	473	6:28	1,996
Delta	9,629.3	477,678	49.6	60	20,567	469	6:05	2,155
Northeast	7,024.3	345,179	49.1	51	15,703	448	7:22	2,067
Trans World	16,466.1	952,641	57.9	66	34,632	476	6:34	2,375
880 Total	33,498.6	1,791,222	53.5	60	71,703	467	6:34	2,239
SUD CARAVELLE								
United	2,121.1	87,432	41.2	65	5,750	369	3:57	1,248
CANADAIR CL-44								
Flying Tigers					4,933	345	5:44	850
Seaboard	116.7				2,254	324		775
CL-44 Total	116.7				7,187	338		828
AW 650 ARGOSY								
Riddle					10,027	237	6:22	481
LOCKHEED ELECTRA								
American	16,670.5	696,705	41.9	59	56,904	293	5:31	758
Braniff	4,839.8	207,379	42.8	62	15,721	309	5:23	759
Eastern	23,481.8	760,976	32.4	47	81,753	267	5:45	750
National	8,913.5	367,017	41.2	50	29,598	302	6:17	724
Northwest	9,784.1	413,205	42.3	57	30,942	316	6:02	765
Western	7,092.1	326,491	46.0	57	22,573	315	5:57	720
Electra Total	70,761.8	2,773,773	39.2	54	237,491	298	5:47	748
VICKERS VISCOUNT								
Continental	9,947.4	266,583	26.6	51	38,185	261	8:17	512
Northeast	5,736.2	152,822	26.6	60	25,174	228	6:39	482
United/Capital	30,070.9	748,451	24.9	55	128,610	234	7:42	467
Bronniff Interchange	164.0	6,137	37.4	67	667	246		517
Viscount Total	45,918.5	1,171,993	25.5	55	192,836	239	7:39	478
FAIRCHILD F-27								
Alaska	2,094.9	53,471	25.5	64	10,711	196	4:53	266
Bonanza	4,390.0	79,748	18.2	48	20,946	210	6:41	259
Mo Consolidated	949.1	7,674	8.1	36	4,635	218	4:14	220
Ozark	1,469.5	27,106	18.4	46	7,708	193	7:02	271
Pacific	2,026.3	44,730	22.1	55	10,187	199	4:39	275
Piedmont	3,589.3	62,108	17.3	48	19,414	186	6:39	262
West Coast	3,420.1	64,379	18.8	47	17,568	195	7:59	260
Wien Alaska	546.5	7,105	13.0	54	2,400	238	3:17	214
F-27 Total	18,485.7	346,321	18.7	50	93,569	199	6:01	260



Boeing turbine transports . . . for every route—5 to 5400 miles

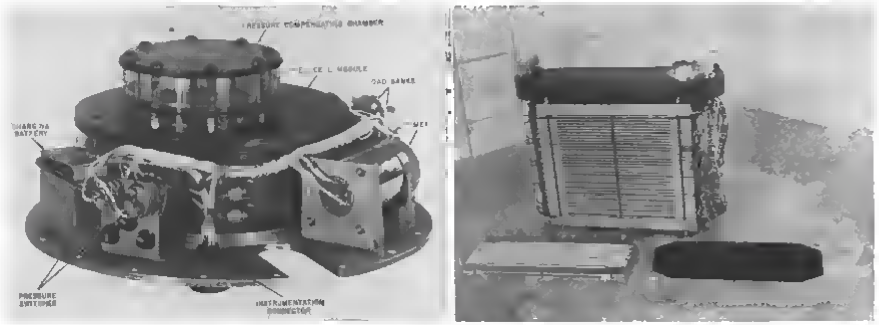
The Boeing family of turbine-powered aircraft is designed to serve profitably every route stage, from nonstop over ocean routes of 5400 miles, to short helicopter hops.

Members of the Boeing family, reading from top to bottom in the pictures above, are the medium to long range 707-120B, the new short-range 727, the 707-320B Intercontinental, the medium range 720 and 720B and the Boeing-Vertol 107 helicopter. "B" models are powered by turbofan engines.

Airlines flying a variety of routes can acquire, from a single source, turbine equipment that meets the specific performance and passenger-cargo capacity requirements of those routes. The advantages, unique to the Boeing family of jetliners, are many, including substantial savings through interchangeability of components and systems, with resulting inventory and spares economies, and lowered training and maintenance costs.

But even more important, Boeing jetliners have demonstrated outstanding reliability and passenger appeal in more than 480,000,000 miles of commercial operations. These are some of the reasons more airlines have ordered—and re-ordered—more jetliners from Boeing than from any other manufacturer.

BOEING



FIRST FLIGHT TEST of a fuel cell under zero-g conditions took place in October, 1960, when a General Electric hydrogen-oxygen cell flew down the Atlantic Missile Range. Complete cell system is at left, stack of cells, with one cell in front, is at right.

Fuel Cell Development Pushed for Space

By George Alexander

New York—Fuel cells now under development for the Apollo and Gemini manned spacecraft will pace development of this particular energy conversion technology and, in the process, lay the foundation for future industrial and consumer applications of cells.

Pratt & Whitney Aircraft Division of United Aircraft Corp. has been selected by North American Aviation, Inc., Apollo prime contractor, to develop the fuel cell system that will provide electrical power for the three-man Apollo spacecraft. General Electric's Direct Energy Conversion Operation, Lynn, Mass., was chosen by McDonnell Aircraft Corp., Gemini prime contractor, to build a cell system for the two-man Gemini capsule (AW Mar. 12, p. 313). Both selections were made with the approval of the National Aeronautics and Space Administration.

Originally, NASA and North American had planned to have parallel development of a primary and a back up fuel cell for the Apollo vehicle with Pratt & Whitney developing the primary system and the team of Tapco Division of Thompson Ramo Wooldridge, Inc., and Ionics, Inc., building the back-up cell. North American, however, recently was instructed by NASA's Manned Space Flight Center at Houston, Tex., to discontinue negotiations with Tapco-Ionics as a second source, pending a review of the varying power requirements of different Apollo missions. One informed source told AVIATION WEEK that NASA had second thoughts about funding three full scale hardware programs in fuel cells, since P&W's and GE's efforts cover the two major types of cells—liquid and solid electrolyte units.

The fuel cell basically is a device which converts the energy of a chemical reaction between a fuel and an oxidizer directly into low-voltage direct-current electricity.

A typical cell consists of two electrodes, an electrolyte and separate chambers for introduction of the fuel and oxidizer into opposite sides of the cell. Electrodes are porous and usually are impregnated with a catalytic material. On some cells, the catalyst is a separate sheet pressed against the electrode surface. Electrolyte can be either a liquid solution or a solid substance, but it must be a good ion conductor.

CUTAWAY MODEL of a typical fuel cell system, built by Pratt & Whitney, shows stacks of cells (left), radiator (right), and fuel and oxidizer reservoirs.

In operation, hydrogen (or the fuel) enters the anode, or positive side of the cell and impinges on the electrode. Under pressure, hydrogen molecules enter the pores of the electrode, react with the catalytic agent and break up into individual atoms. In a liquid electrolyte cell, the electrolyte solution enters the other side of the electrode's pores to a depth determined by the solution's viscosity and the pressure behind the hydrogen.

Reaction occurs within the pore where hydrogen atoms, catalytic agent and electrolyte meet. The hydrogen atoms react with hydroxyl ions found in the electrolyte solution to form water and to release electrons to the electrode. These electrons flow through an external circuit, performing work and then return to the cathode side of the cell.

At the cathode side of the cell, oxygen is forced through the pores of the second electrode and reacts with the electrolyte, again in the presence of catalytic agents within the pore. Hydroxyl ions and either free oxygen or water are formed, with the ions passing through the pore into the electrolyte to balance those lost at the start of the sequence and the latter drawn off in one way or another.

Although a cell can use almost any fuel and oxidizer to generate a current flow, McDonnell and North American, with NASA's approval, specified hydrogen and oxygen for the Gemini and Apollo fuel cell systems.

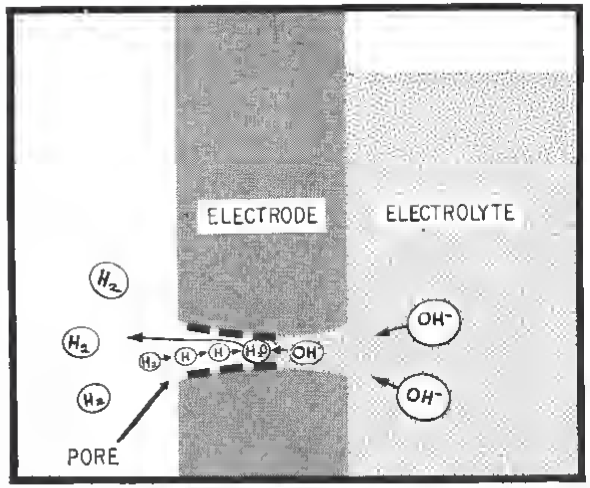
This selection was based on several factors. The hydrogen-oxygen cell has a higher theoretical output (1,620 watt-hour per lb. of gases) than any other fuel-oxidizer combination. The waste product of a hydrogen-oxygen cell, formed after the gases have reacted, is potable water for the spacecraft crew. A central cryogenic O_2 reservoir could supply oxygen both to the fuel cell as well as to the capsule's life support environment, thus simplifying tankage problems and reducing total systems weight. Separate O_2 tanks for the fuel cell and capsule environment, however, are possible if NASA and the contractors decide that safety requirements necessitate duplication.

Gemini capsule will require about 1,700 w. peak to operate all on-board electrical systems, according to present NASA and McDonnell estimates. Apollo will need between 1.7 to 2 kw., depending on the mission, NASA and North American now estimate. Power requirements for both vehicles could go higher.

Fuel cells inherently are low-voltage devices. Like batteries, they must be connected in series to raise total voltage and in parallel to increase amperage.

To achieve a main line (bus) voltage of 28 v. and power between 1.7 and 2 kw., the arrangement of fuel cells in the Gemini and Apollo power systems will be very similar: upwards of several dozen cells will be series-connected in a module to provide the desired bus voltage. A number of modules then will be connected in parallel to raise the amperage to the power level required and will constitute a section.

Three sections, connected in parallel and cross-manifolded for reliability and safety, comprise the core of the electrical generation system in the spacecraft. Under normal conditions, power will be drawn from two sections while the third will be held in emergency reserve. The output of any individual section will have to be sufficient to drive a minimum of critical equipment in the event of a major spacecraft emergency—such as an abort—and any module or section that fails will be shut down individually and isolated.



REACTION IN A FUEL CELL occurs when hydrogen molecules enter the electrode's pores, break up under the action of the catalyst (black bars within pore) and meet with hydroxyl ions in the electrolyte solution. Electrons are given up to electrode and water is formed.

The Gemini fuel cell, which GE's Direct Energy Conversion Operation will develop, is of the ion-exchange membrane—or solid electrolyte—type. Identified only as Polymer A-prime by the company for proprietary reasons, the membrane is an ion-permeable plastic sheet less than ¼-in. thick and is placed between two electrodes. Hydrogen is fed into the anode side of the cell under low pressure and passes through to the far side of the porous electrode. At the interface between the electrode and membrane, the hydrogen molecules dissociate, releasing electrons to the electrode and hydrogen ions to the membrane. The ions are conducted by the membrane to the cathode where they combine with the returning electrons in the presence of oxygen, thus forming water. The water is drained off the oxygen side of the cell through wicks so as to control its flow and to maintain the moisture level required by the membrane for good conduction. Cell temperature is less than 200F.

The cell that was developed for Apollo by the Tapco-Ionics team featured a dual membrane, electrodes, separate catalyst and a liquid acid electrolyte. It was similar, in some respects, to the GE cell, but had two membranes instead of one and employed a truly liquid electrolyte.

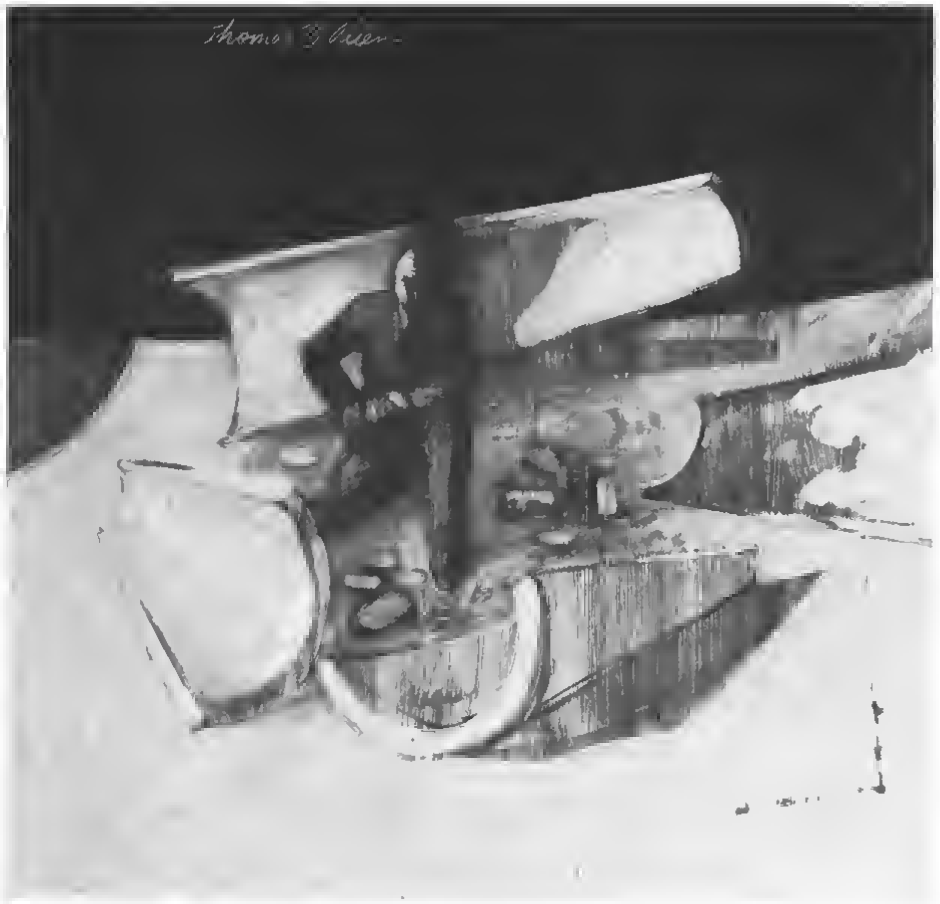
The dual membrane contains the electrolyte solution. The catalytic agent is coated on the outside membrane wall and is sandwiched between it and the electrode. The electrode faces the hydrogen (or oxygen) chamber. Cell pressure is about 25 psia and operating temperature is 170 to 210F.

Reason for the dual membrane, according to Tapco-Ionics, is safety. With a dual membrane, mixing of the gases—should it occur—would take place in the non-reactive electrolyte solution and an explosion is unlikely.

Reaction in the Tapco-Ionics cell occurs at the interface between the catalytic coating and the electrode, both of which are pressed together. As the hydrogen atoms and ions from the electrolyte meet, electrons are given up to the electrode and water is formed. The water is allowed to seep into the electrolyte solution, where it is distilled later.

Pratt & Whitney is developing a cell on a design held under patent by the Leesona Corp. Called a Bacon type after Francis T. Bacon, an English scientist who evolved its design during the 1930s and 1940s, the P&W cell consists of nickel and nickel oxide electrodes and a concentrated solution of potassium hydroxide as the electrolyte. Nickel acts as its own catalyst for heated gases—especially hydrogen when it is heated to 200-250C. Cell pressure ranges from atmospheric to about 100 psia. Its operation is along the lines of a typical fuel cell.

NASA, McDonnell and North American favor the fuel cell over conventional and other exotic power systems for Gemini and Apollo because of the cell's expected performance and availability. Compared with a conventional battery, the cell has the advantages of longer



THE SKEPTICAL MEN

"... habits," wrote John Dryden, "gather by unseen degrees,—
As brooks make rivers, rivers run to seas."

All men are susceptible to the accumulation of habits. It's a natural part of our lives to do things with a certain repetition.

But in industry, accepted ways of doing things, based merely on repetition, can prove expensive.

Because of the complexity of projects carried out by the aerospace industry, it has been looking with increased skepticism on accepted methods of doing things. As a result there have arisen whole new approaches within management—approaches fulfilled by men in value analysis, quality control, product reliability.

These men, working together, and working closely with engineers and purchasing agents, help cut needless expense while maintaining and increasing high levels of reliability.

Some of the questions they ask are: "What is the item?" "What is the function?" "What does it cost?" "What else would do?" "What would that cost?"

Questions such as these may sometimes make their work difficult in the area of human relations, but as the scope of the work is better understood these problems decrease. For this new approach is more than just mere cost consciousness. It is a highly creative method that allows management to overcome roadblocks of pre conceived ideas.

Analysis of function is now spreading to every level of production—from top management to the design engineer to the purchasing agent to the man on the line.

This is one of the ways the aerospace industry is helping America get the most for its defense and space money. It has already paid off in millions of dollars saved.

This is the work of men who are not willing to accept the accepted.

This is the work of the skeptical men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems

This quiet revolution in components

vitally affects your avionics equipment reliability

Without benefit of fanfare the electronic vacuum tube has quietly made astonishing gains in reliability over the past decade. Data accumulated from 1952 to date on Sylvania Gold Brand Subminiature Tubes reveal an impressive decline in percent failure rate—*from an average of 5.5%/1000 hours to approximately 0.25%/1000 hours.*

Compiled under combinations of *max-rated plate and screen dissipation and max-rated bulb temperatures*, these figures demonstrate that vacuum tubes provide both high performance and high reliability.

Tubes are remarkably tough operators. Case in point: GB Gold Brand Tubes specifically designed for business-commercial aviation. Sylvania subjects them to conditions far more severe than encountered in actual field usage. Example: shocks of 500g, fatigue tests of 2.5g for 96 hours, bulb temperatures of 165°C. Large samples are life tested under high temperatures for 500 and 1000 hours. In all, Sylvania GB Gold Brand Tubes are built to assure dependable operation of your electronic "eyes and ears."

If avionics equipment reliability concerns you, be specific about the components you use. Make certain they are superior-quality electronic tubes—look for the Sylvania GB Gold Brand marking on the tube. A complete list of GB Gold Brand types, and prototypes, is yours for the writing. Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

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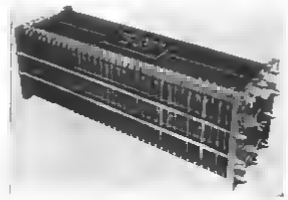

UNION CARBIDE'S fuel cell module can deliver 28 v., about 0.6 kw. of power, operates at between 5 and 10 atmospheres

lifetime, lesser weight (on a kw. hr./lb. basis), higher efficiency, lower heat and simpler design.

Fuel cells have efficiencies from 40% to 90%—compared with 15% for thermoelectric and solar systems and 30% for gas turbines.

When matched against other exotic types of electrical conversion devices—such as thermionic converters, photoelectric emitters, dynamic heat engines, nuclear and plasma generators—the cell may have any one or several of the advantages given above but its biggest comparative value is that it is further along than any other unit.

Fuel cells have debits as well as assets. They generally cannot deliver large amounts of power over short time periods, nor are their power-to-weight and power-to-volume ratios as high as some batteries—such as silver-zinc units. Like batteries, fuel cells require inverters to change their d.c. output to alternating current for some electronic systems. Some cells require a considerable amount of auxiliary equipment—feed lines, valves, pressure sensors, controls, heat exchangers, etc.—for operation.

To assist and back up the fuel cells in handling peak loads, Gemini and Apollo will carry conventional batteries.

Within the cell itself, there are problems of electrode porosity and corrosion, formation of insolubles in the electrolyte, dilution of the electrolyte by the water formed, and polarization losses. Polarization may be described as the energy lost to the cell in starting and sustaining the chemical reaction that is the heart of the cell.

There are three basic types of polarization: activation, which is the energy required by the catalyst to break up gas molecules; concentration, which limits the rate of replenishment of ions within the electrolyte as they are used at the anode and cathode; and ohmic, which is the total internal resistance of the cell. Taken together, these polarization losses reduce actual cell voltage from that which is theoretically possible.

It is for this reason that the most meaningful measurement of any cell's efficiency is its current density, or number of amperes that can be drawn from

BRINGING OUTER SPACE "DOWN TO EARTH"

(Or: Reliability revisited)

Norm Froomkin (pronounce it as though there were only one "o") tells a story that sticks in the mind. A short while ago, Norm, who heads up Test Facilities Engineering at Budd Electronics, was discussing with an Air Force General the various and sundry inputs required for reliability testing of spacecraft. The General suddenly stopped, looked at Norm, and said, "You know what we really need to build? *An acre of the moon!*"

With due regard for the General's inspired cogitation, we're sure there are many others who long for a slice of lunar environment here on terra firma. What makes the idea so memorable is that it pretty well sums up the whole problem of getting our spacecraft . . . and our spacemen . . . to their destinations *with nothing less than 100% reliability.*

The problem basically is one of getting enough operational failure mode data.* (Is there ever enough?) Getting it from actual launchings is too costly and too slow . . . and, in the case of manned craft, unthinkable. Some of it we can get from single-force testing of materials and subsystems. But statistical extrapolation . . . from system elements under single forces to subsystems and complete vehicles in omniforce spatial environments . . . is not going to assure us 100% package reliability. We may have a good idea of the type and magnitude of the space force envelope, but what about the complex interacting and intermodulating stresses it produces on spacecraft? The solution . . . it becomes clearer every day . . . has got to come down to total simulation of space environments.

There's nothing new about the idea of simulative force testing as a means of assuring performance reliability . . . at least not here at Budd. It's been a way of life with us for nearly 50 years, put into practice on our own products in our own testing facilities. To this experience, Budd Test Facilities Engineering adds a thorough familiarity with force environments and their simulation . . . stress interactions and their analysis . . . and test facility design, construction and instrumentation. And that's giving you the story at Mach 5. It's actually conservative to say that every scientific and engineering discipline has to come into play in building what we call a Dynamic Omniforce Testing Facility.

We supply such facilities . . . as well as those for more conventional testing . . . on a turnkey basis, from force system analysis to final checkout. We also supply individual test modules for specific jobs, and consulting services on testing programs. If we've whetted your appetite, your letter or phone call will bring you more information or a provocative discussion of your needs. Test Facilities Engineering, Budd Electronics, 43-22 Queens St., Long Island City 1, New York.

*R & D terminology for "Why didn't it work this time?"

Budd ELECTRONICS

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Data Processing & Display Systems
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Environmental Control Systems
Test Facilities Engineering

a given square unit of electrode surface—amps per sq. ft. or milliamps per sq. cm. This figure represents the current flow that can be generated from a voltage applied through the cell's electrolyte, for an electrode of given size and material.

Not all of these problems are insolvable. Heating the gas for example, before it enters the cell makes the job of the catalyst a little easier. But it also adds another problem of rejecting nonproductive heat.

Because there is no combustion within a cell, fuel cells are not subject to Carnot's (19th century French physicist) heat law—which states that the heat output of a device is equal to the amount of heat input minus internal losses.

Nonetheless, fuel cells do generate some heat and some cells require heat to aid the catalytic reaction. This heat must be dissipated.

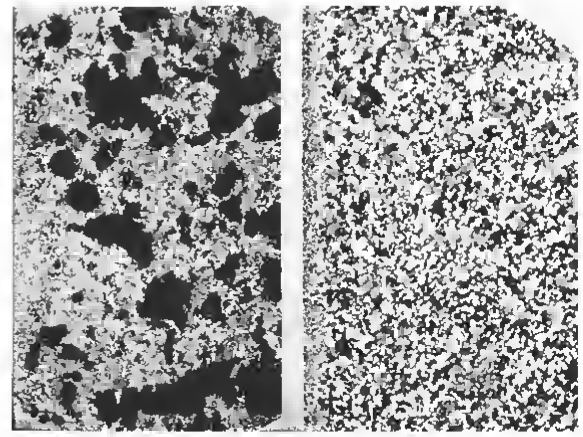
On the Apollo spacecraft, present NASA and North American plans envision a radiator around the circumference of the service module, which is situated behind the manned command module. The fuel cell power system also will be located within the service module.

The radiator will differ for the earth orbit and circumlunar missions of Apollo and the lunar landing mission of the three-man spacecraft, because of the different temperature environments in which the system's heat will be radiated. The crux of heat radiation is the difference between the temperature of the heat being emitted from the spacecraft and the temperature of the surrounding environment. The greater this temperature differential, the more heat may be more easily dissipated.

In space where there is effectively no ambient temperature, low temperature heat can be dumped readily. On the lunar surface, however, where the ambient temperature is expected to run between 100C and 140C in direct sunlight, the temperature of the spacecraft's radiated heat will have to be considerably higher.

GE plans to draw heat from its cell by circulating an inert gas through the cell and then ducting the heated gas to the radiator. It is understood that Tapco Ionics has experimented with a circulating electrolyte solution. Pratt & Whitney's fuel cell is understood to reject heat by circulating excess hydrogen through the cell. The gas removes both heat and water from the cell, with the latter subsequently condensed and drawn off.

Pratt & Whitney will be required to deliver a cell for NASA's and North American's evaluation no later than mid-1963. GE will be called upon to demonstrate its cell to NASA and McDonnell no earlier than this autumn but no later than the beginning of next year. Reliability figure specified for these fuel cells starts at 9995—and is expected to rise as development progresses.



DIFFERENCE IN POROSITY of an early-model Pratt & Whitney electrode (left) and a more recent plate (right) is clearly visible

In addition to GE, Pratt & Whitney and Tapco Ionics, firms developing fuel cells include Aerojet-General Corp., Allis-Chalmers Mfg. Co., Allison Division of General Motors, Armour Research Institute, California Research Corp., Chrysler Corp., Consolidation Coal Co., Curtiss-Wright Corp., Dow Chemical Co., Electric Autolite Co., Electric Storage Battery Co., Electro-Optical Systems, Inc., Engelhard Industries, Inc., Esso Research and Engineering Co., Hoffman Electronics Corp., M. W. Kellogg Co., Koppers Co., Leesona Corp., Lockheed Aircraft Corp., Minn. Mfg. & Mining Co., Monsanto Chemical Co., Radio Corp. of America, Resin Research Laboratories, Speer Carbon Co., Sundstrand Machine Tool Co., Union Carbide Corp., Consumer Products Co., National Carbon Co. and Westinghouse Electric Corp. The list is by no means exhaustive.

There also are a number of U.S. and foreign universities doing basic fuel cell research under Army, Navy and Air Force contracts, as well as several European firms.

Soviet Union also is conducting research on cells.

Allis-Chalmers, which has active in the Gemini and Apollo fuel cells bidding, has investigated a variety of fuel oxidizer combinations in cells in addition to a hydrogen-oxygen unit. In the hydrogen-oxygen cell which the company proposed for the NASA spacecraft, Allis-Chalmers used a plastic-like lining to contain the electrolyte between the electrodes—similar to the dual membrane configuration of the Tapco-Ionics design. Use of the lining the company said allowed employment of simple inexpensive high porosity electrodes and eliminated the need of wet proofing the collectors. The cell was said to operate at 5 psig and 165F.

In late 1959, Allis-Chalmers assembled 1,008 cells—112 modules containing nine parallel-connected units—to drive a farm tractor with 15 kw of power. Fuel was understood to have been propane and oxidizer was tank oxygen.

Allison is investigating a nuclear fuel cell with liquid metal electrodes—mercury and an amalgam of mercury and potassium—separated by a porous matrix saturated with a molten electrolyte. A nuclear reactor would be the heat source for liquifying the metals.

In operation the liquid metals would be pumped along opposite sides of the electrolytic matrix and the consequent chemical reaction would induce a potential across the electrodes. Current is then generated and tapped. The metals would be pumped out of the cell through a common drain and fed into a reactor-heated boiler, where the more volatile mercury would be boiled off at the top and the amalgam siphoned off from the side of the boiler.

Esso Research and Engineering Co. is studying a variety of hydrocarbon fuels—such as methanol, isopropanol and ethylene glycol—in low temperature cells. Aerojet has been looking at a zinc-chlorine cell with sea water as the electrolyte for maritime applications.

Monsanto's research efforts have been directed toward fuel oxidizer combina-

tion that also would be used as propellants in upper stages—such as hydrazine and nitrogen tetroxide. A fuel cell using these chemicals could be fed from a tap-off on the payload's propulsion pack, thus saving weight and space.

Union Carbide's Consumer Products Co. and National Carbon Co., not surprisingly, have concentrated on carbon electrodes with various types of electrolytes and fuels—especially hydrogen-oxygen. National Carbon has been studying a porous carbon cathode with an amalgam-covered steel anode and an electrolyte of liquid sodium amalgam.

Soviet Research

Soviet scientists have reported research work on cells based on hydrogen-oxygen, molten salts and vaporized hydrocarbons. A Soviet hydrogen-oxygen cell, using a mixture of sodium carbonate, monazite, tungsten oxide and soda glass as the electrolyte, was said to have operated for as long as 20 hr. at 700C. Current densities of 30 a.-ft.^{2} and 0.76 v. have been claimed.

Most of the cells described above are of the non-regenerative type, i.e., there is no attempt made to re-use either the fuel or oxidizer after reaction has occurred. Some companies, however, are working on regenerative cells in which the waste product—such as water—is electrolyzed to form hydrogen and oxygen. The gases then are fed back into the cell.

Regenerative cells require some external power to bring about decomposition of the waste product and are necessarily more complex than non-regenerative types. They generally lag behind non-regenerative cells in present development. More akin to conventional storage batteries, regenerative fuel cells are foreseen to have a future in space applications where the electrical storage requirement of a spacecraft is greater than that for continuous power generation.

Third Category

There is a third category of cell called Redox for reductant-oxidant. In this type of cell, the anode and cathode are immersed in individual electrolyte solutions, separated by an impermeable ion-conducting membrane. By using chemical intermediates to convert the energy of reaction into electricity, the Redox cell eliminates the difficulties associated with electrode porosity. It also is adaptable to fuels of varying degrees of purity.

Estimating the cost of any given fuel cell is difficult because of the many variables involved—electrode and electrolyte materials, desired efficiency, power output, size, weight, auxiliary equipment, etc. Electrodes probably represent the largest single cost in a cell because of the expensive nature of the material itself—such as nickel or platinum—and the processing required to produce the necessary porosity.

Total cell system costs can run from several dollars per square foot of cell area to upwards of more than $100 per square foot.

But all engaged in fuel cell research and development today agree that costs will go down as programs progress and if large-scale production is ordered, either by the government or by industry.

The brightest future for cells appears to be not in space but in industrial and consumer applications. Most U.S. space scientists—civilian as well as military—see the non-regenerative fuel cell as a bridge between conventional battery power systems and nuclear sources. Industry also seems to feel this way, viewing the space-development of fuel cells as the springboard to large dollar markets years from now when cells have proven themselves.

Consumer Uses

Natural gas companies are said to be interested in the prospects of fuel cells supplying heat and power in homes. Power companies are intrigued by the use of large fuel cell systems in remote areas where hydrodynamic power is not available. There also is much speculation about electric automobiles powered by fuel cells. Practical problems involved are such, however, that no fuel cell advocate is predicting achievement of these goals for many years to come.

In space, fuel cells probably will find application in roving lunar vehicles and spacecraft with useful lifetimes of three to six weeks. A longer-lived space vehicle would demand prohibitively large amounts of chemicals for its fuel cell system and so incline toward a nuclear unit instead. Shorter-lived vehicles, aside from manned spacecraft, would not make maximum use of the fuel cell's advantages to justify the cost of such a system.

Areas Probe Carries Multiple Experiments

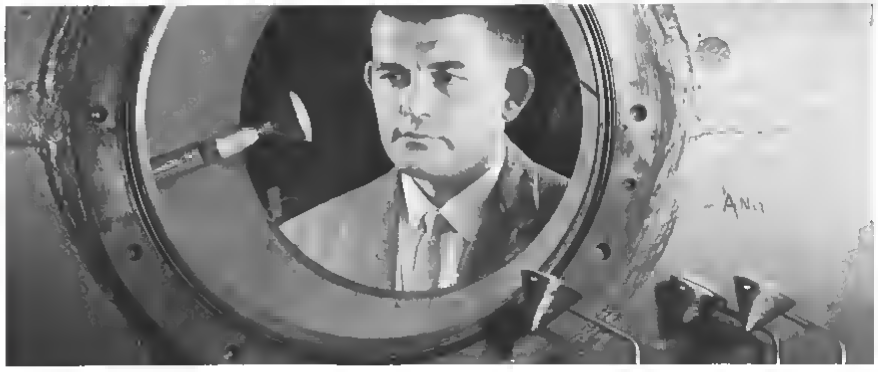
Biological experiment package has been launched in surplus payload space of an Arcas meteorological rocket probe as the first operation in Project Papoose being conducted by Naval Missile Center, Pt. Mugu, Calif., to get extra data from space by installing secondary experiments on research vehicles whenever extra weight will not compromise the primary experiment.

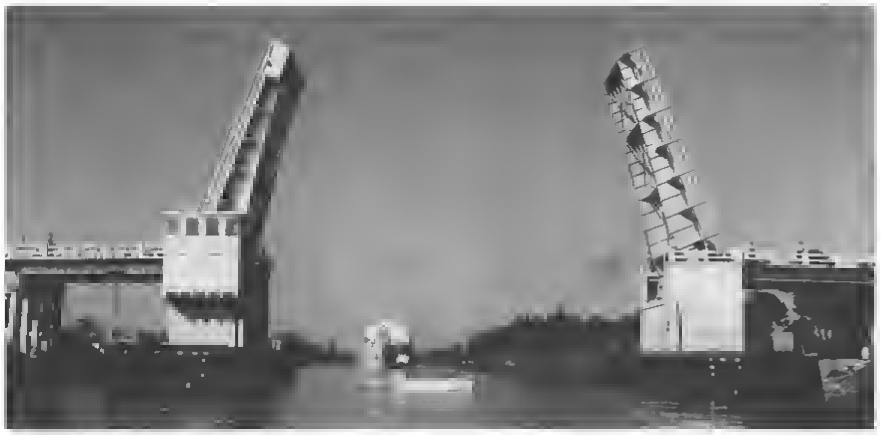
The first Papoose package carried a living animal cell culture and stacks of photographic plates to gather more information on cosmic radiation effects. The Arcas nose cone was lengthened to accommodate the extra payload.

Dummy Mercury capsule is shown dangling from Rogallo wing at Langley Field, Va. More advanced version of the wing, folded in the spacecraft at launch and deployed as a parachute upon re-entry, will be used in Gemini launchings.

Apollo Designs Studied by NASA

Wind tunnel tests in Langley Research Center's Unitary Plan Tunnel (right), and 22-in. Helium Tunnel (below), were among several specialized investigations providing data used in design of the Apollo spacecraft. Rogallo wing, seen above, is being evaluated in Apollo recovery program (AW Apr. 2, p. 17). Technician at right wears an aluminized suit to change the test specimen without waiting for the tunnel to cool.





Barge Promise carries S-1 stage of the second Saturn test vehicle into Fort Canaveral from the Marshall Space Flight Center assembly point at Huntsville, Ala. This booster is designated SA-2 and is scheduled for launch in late April.

Saturn Rocket Readied For Second Launch

Final preparations are under way at the Atlantic Missile Range for the second development flight of the Saturn C-1 vehicle's S-1 booster stage scheduled for late this month. The booster with a dummy S-4 second stage and a dummy S-5 third stage weighted to simulate an Apollo capsule will be launched on a ballistic trajectory for tests of systems and components.

S-1 booster consists of a cluster of eight Rocketdyne H-1 kerosene-oxygen engines, which will produce a thrust of 1.3 million lb. Operational boosters will have a thrust of 1.5 million lb. First 11 boosters—one used for ground tests and the others for flight tests—are being manufactured at National Aeronautics and Space Administration's Marshall Space Flight Center in Huntsville, Ala.

Final steps in the transportation from Huntsville to Cape Canaveral, Fla., are shown in these pictures.

Flight boosters from Number 10 on will be fabricated by Chrysler Corp. at the Michoud, La., manufacturing plant, which will reduce transportation time and complexity.

Experience in assembling the C-1 development vehicle on Pad 34 at AMR has prompted NASA to look at simpler and less costly methods for assembling the advanced Saturn C-5 vehicle.

The result is the use of a vertical assembly technique (AW Mar. 26, p. 54) which will reduce the present three-month pad time to about two weeks.

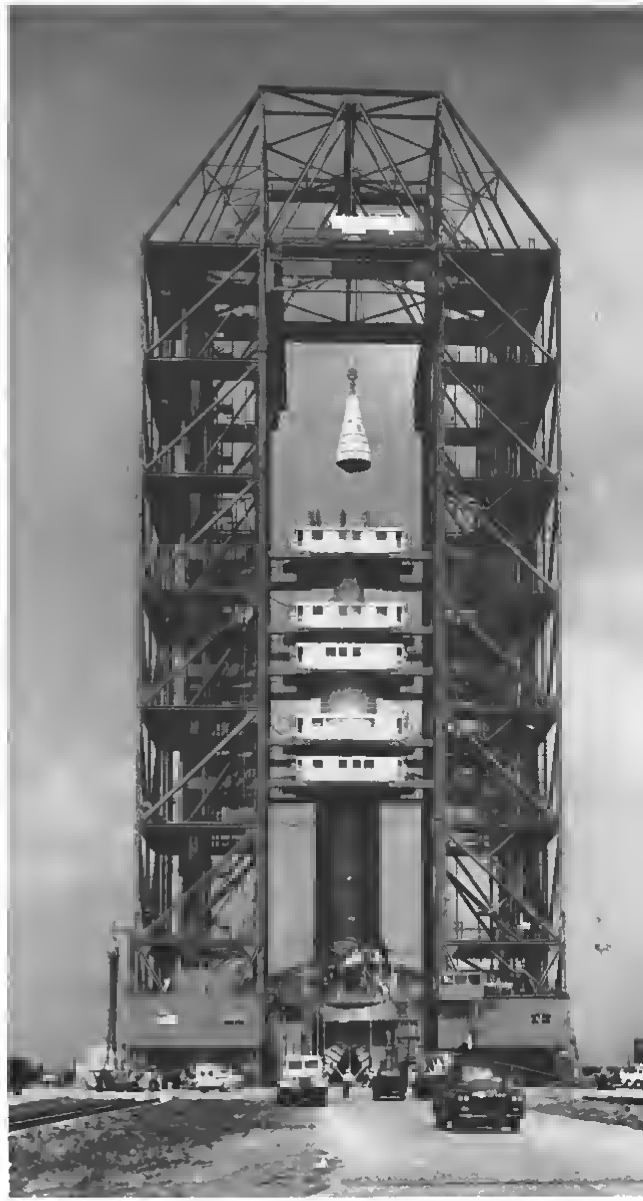
First Saturn flight vehicle, designated SA-1, was launched Oct. 27 (AW Nov. 6, p. 30), and made a highly successful 483.6 sec. flight. Maximum altitude reached was 84.8 mi., and range was 214.7 mi. Peak velocity was 3,607 mph.

The SA-2 vehicle completed static tests at Marshall last October, and the SA-3 booster recently entered its static test firing phase. First live second stage will be flown aboard SA-5, which also will be the first Saturn to include fins for aerodynamic stability.

The Complex 34 launch site service structure is 310 ft. high and has a bridge crane with a 60-ton capacity. There is one work deck at the 27-ft. level, seven fixed platforms and five movable, horizontally-retracting platforms. The complex, which includes the service tower, launch control center, fuel and liquid oxygen storage facilities as well as a 438-ft.-dia. launch pad, covers an area of approximately 45 acres at the Atlantic Missile Range.

Neighboring launch facility, Complex 37, will contain two launch positions for C-1 vehicles. All construction work on this facility is expected to be completed by June, 1963.

SA-2 booster is off-loaded on transporter at Cape Canaveral. Eight engine S-1 stage has 21.6 ft. dia. For test hops, engines develop 1.3 million lb. thrust. Normal thrust will be 1.5 million lb.



Dummy nose cap is erected on the second Saturn test vehicle on Pad 34 at the Atlantic Missile Range. Vertical assembly techniques are planned for advanced launch complexes at AMR (AW Mar. 26, p. 54) to cut pad time to two weeks or less.

HONEYWELL ADAPTIVE CONTROL SYSTEM NOW FLIES THE X-15

EXTRA HIGH RELIABILITY AND SAFETY BUILT INTO X-15 SYSTEM Extraordinary demands placed upon both man and machine in a typical X 15 mission require extremely high reliability and safety factors The Honeywell adaptive system will inherently adjust to maintain satisfactory performance should one of its electronic elements fail By duplicating many critical elements Honeywell engineers have been able to design the X 15 system to "bridge across" not only single failures but most multiple malfunctions (highly unlikely to occur) Furthermore, each part has been designed with an extra margin of reliability All these factors contribute to make the X 15 system the safest flight control system ever flown.

Flight-proven, qualified system gives uniform control throughout vast range of speeds and altitudes

A reliable automatic flight control system that adjusts itself to the entire range of aero-space flight dynamics—this is the new Honeywell Adaptive Autopilot developed under the auspices of the Flight Control Laboratory ASD Air Force Systems Command and now flying one of the X 15 rocket research vehicles Proved in hundreds of hours of flight tests in a supersonic F 101A the performance of the adaptive system has been enthusiastically accepted by 18 experienced Air Force, Navy and NASA test pilots

Unlike conventional linear autopilots, the Honeywell Adaptive System does not require continuous information such as air density and speed Instead, the system maintains control by continually measuring its own response and adjusting itself to keep that response optimum under all flight conditions

As the X 15 climbs toward thinner air the Honeywell Adaptive System automatically adjusts the control surface displacement and blends the reaction jets with the conventional aerodynamic controls until, at a very high altitude the reaction jets alone must steer and stabilize the craft. During re entry as the air gets thicker the system blends in the aerodynamic controls as they become effective This conserves reaction jet fuel and gives the pilot full command of the critical re entry maneuver

While it provides effective flight control throughout an extremely wide, dynamic range the Honeywell Adaptive System requires far less advance knowledge of the aerodynamic characteristics of the craft to be flown (some of the X 15's characteristics are still unknown), and requires far less flight proof time (the flight controls in the X-15 will be fully flight proven in 40 minutes)

Honeywell is designing and building a similar Adaptive Flight Control System for the Dyna Soar manned space glider and is using the same basic principles for other applications such as business aircraft helicopters drones supersonic fighters, and bombers, as well as missiles and rockets

The X 15 is manufactured by North American Aviation for the joint Air Force NASA and Navy research project It has made substantial contributions to the knowledge of man's ability to function effectively in spacecraft and it is furnishing valuable facts to supplement theory on structures metals fuels engine performance and design techniques

For further information on Honeywell's space and weapons systems capabilities, write Honeywell Military Products Group, Minneapolis 8, Minn Dept. AW-4-36

This advertisement is paid for by Honeywell, not from government funds While it is a report concerned with our nation's defense and space exploration programs, it is primarily intended to acquaint you with Honeywell's capabilities It is particularly addressed to companies seeking help in areas where Honeywell research and practical experience can be most useful Your inquiries are invited This material has been cleared for publication by the Government agencies, contractors and companies concerned.

Airborne analyzer conducts "Go, No-Go" equipment checkout

A Honeywell developed Airborne Checkout System is carried aboard the B 52 mothership Connected by an "umbilical cord" to the X 15 it automatically makes 78 separate pre flight checks on the operation of the X 15 flight control system in less than 3 minutes At the push of a "Start" button the analyzer first self-checks its own operation then checks each of the 78 circuits in the flight control system If any circuit is not functioning properly the analyzer stops and indicates which circuit is faulty The operator then decides whether it is a serious enough malfunction to call off the flight or whether it is a minor matter which the pilot can override If the decision is to override the operator again pushes the "Start" button and the analyzer completes the checkout.

Computer center solves space, business problems

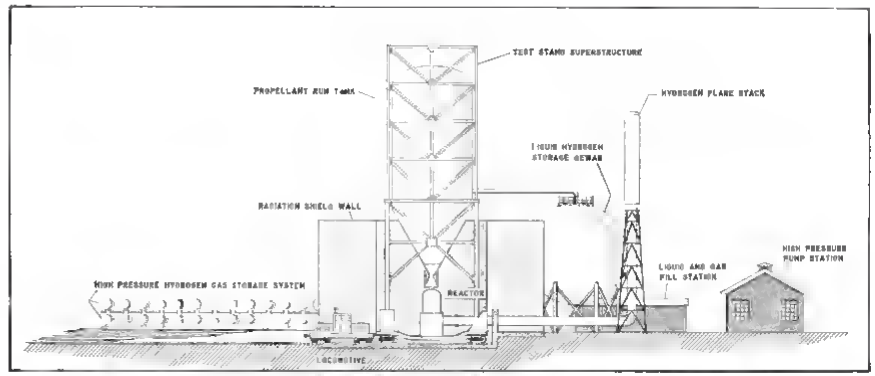
A battery of analog computers was used to conduct flight simulation studies in analyzing the requirements of the X 15 Adaptive System. Now in a Honeywell Computer Center these analog computers are coordinated with a Honeywell 800 digital computer into one system (A digital computer displays its answers in numbers, an analog computer produces results in graph form) This is believed to be the first installation in industry to perform both analog and digital scientific computation while simultaneously handling business problems

The center will handle the huge amount of computation involved in the development of control systems and will even be used to solve the problem of scheduling its own time to meet the needs of the many departments it will serve.

Honeywell

Military Products Group

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany France, and Japan.



THIS IS A GENERALIZED DESIGN of a $7.1 million radiation effects facility planned at the National Nuclear Rocket Development Station, Jackass Flats, Nev. In it, nuclear rocket components will be tested in an environment similar to that in a full-power nuclear engine run. This facility will be built around a low power reactor able to run for extended periods of time.

Space Agency's Fiscal 1963 Construction Plans—Part 2:

NASA to Expand Nerva, Rift Facilities

By Edward H. Kolcum

Washington—Large percentage of new construction outside the Florida and Gulf Coast areas in National Aeronautics and Space Administration's Fiscal 1963 requests is earmarked for expansion of the agency's nuclear rocket development program, with approximately $80 million in new facilities at two major nuclear installations—National Nuclear Rocket Development Station at Jackass Flats, Nev., and Plum Brook Station near Sandusky, Ohio.

The $535-million program of new construction for the NASA Crescent—Florida and Gulf Coast—was detailed in Part 1 of this series (AW Mar. 26, p. 54). Another $274 million is requested for new facilities at three stations, two space flight development facilities, four research centers and four tracking sites. The money is to be divided this way:

• **Stations**—Nuclear Rocket Development, $40 million Plum Brook, $39.2 million and Wallops, $4.3 million.

• **Space flight**—Goddard, $23.8 million for new scientific satellite facilities; Jet Propulsion Laboratory, $10.4 million for facilities to support the unmanned lunar and planetary exploration program, and $14.3 million for an advanced antenna system at JPL's Goldstone station.

• **Research centers**—Langley, $20.5 million, including a $12.4 million cyclotron; Ames, $8.1 million; Lewis, $4.6 million and Flight, $1.8 million.

• **Tracking**—Far East data acquisition station, $6 million; Rosman, N. C., data acquisition station, $5 million and advanced antenna systems at Johannesburg, South Africa and Woomera, Australia, $5 million each.

The largest new project at Jackass Flats will be stage static test and maintenance facilities, to cost $20.2 million. Facilities already exist at the site to test nuclear engines, and this request will provide a complex to static test the complete Rift (reactor in flight test) stage.

Expandable Complex

The complex will consist of one engine-vehicle test position, expandable to a three-position stand; a 22,000-sq-ft control center; instrumentation systems; control systems; cryogenics and high pressure gas systems and a stage assembly and maintenance building.

The test position will allow downward firing while the stage is vertical, and it will be capable of full power tests. The stage will be dolly mounted and taken to the test position on a railroad car, eliminating the need for a fixed superstructure which might be affected by radiation.

Exhaust system will be water cooled with a supersonic ejector to carry exhaust from the stand. The control center will be a two story shielded structure, with the first story underground.

Stage assembly and maintenance building is designed for two bays, only one of which is requested in the Fiscal 1963 budget. The bay will be a "warm" area—radioactive but not critical—with 7,000 sq. ft. of floor space, in which work will be done on radioactive stages. A 25-ton crane will be used to handle the stages. Next to the bay will be a workshop of 15,000 sq. ft.

Other sizable facilities at Jackass Flats are:

• **Stage demating, maintenance and disassembly facilities, $8.7 million.** This complex will allow remote connect and disconnect of a hot nuclear engine from the vehicle stage. The building will contain 47,000 sq. ft. of floor space to be used for maintaining radioactive engines and components, cooling stages and test equipment after a hot engine has been demated and minor maintenance of radioactive components.

• **Radiation effects facility, $7.1 million,** required to evaluate performance and develop nuclear rocket components in an environment that would be encountered in a full-power nuclear engine run. The facility is built around a reactor designed to run at low power for long periods.

• **Components test facilities, $1.9 million** for test cells, cold flow test stand and related control and operations systems to be used for nuclear rocket component acceptance tests.

Another $2.1 million is requested for support including a 10,800 sq. ft. central services building, 10,000 sq. ft. electro-mechanical laboratory, a decontamination station and general extension of utilities.

Advanced space propulsion facility, to cost $25.5 million, is the largest project planned at the Plum Brook Sta-

tion and it is designed to permit evaluation and development test of complete advanced power generation and electric propulsion systems in start, power change and shutdown. Major component will be a flight-type nuclear reactor, heavily shielded from the non-nuclear portion of the complex.

Non-nuclear portion of the chamber will be stainless steel, with walls cooled by baffles. Electric rocket exhaust will be cryo-pumped with liquid nitrogen baffles, and local areas will be cooled with gaseous helium.

Plum Brook comes under the administrative direction of the Lewis Research Center, which recently was assigned responsibility for development of the propulsion system for the lunar landing module of the Apollo vehicle. NASA is requesting $6.3 million to construct a test facility able to evaluate altitude performance of the lunar propulsion system, with the facility to be built at Plum Brook.

This complex will consist of a vertical firing test stand, able to accommodate hydrogen-oxygen engines of up to 60,000 lb. thrust, with provisions to assess these engines under partial thrust. Test chamber will be 30 ft. in diameter and 35 ft. high. Altitude will be simulated by using a diffuser on the engine exhaust combined with a multi-stage steam ejector to reduce pressure.

Nuclear rocket dynamics and controls facility at Plum Brook, to cost $3.5 million, involves modification of the existing B-1 altitude rocket test stand for development of nuclear rocket engines and stages.

Critical Problems

Among the most critical problems facing nuclear propulsion, which this facility is expected to help overcome, are controllable fuel pumping cycles, engine start-ups, analysis of inadvertent injection of hydrogen into the reactor core, stability and control of the hydrogen gas pressurization system and multiple pump-turbine combinations.

NASA is requesting $2.4 million to construct a hydrogen heat transfer laboratory able to study storable propellants and flow systems using a pebble bed.

Lunar Mapping System

Jet Propulsion Laboratory is preparing specifications for a photo instrumentation package program expected to lead to a high-resolution photographic mapping system for National Aeronautics and Space Administration's lunar orbital vehicle. JPL decided to start a new program because of the long time lapse since earlier round of similar industry studies for VOIS (Visual Observation Integration Subsystem) in 1960 (AW Oct. 17, 1960, p. 27).

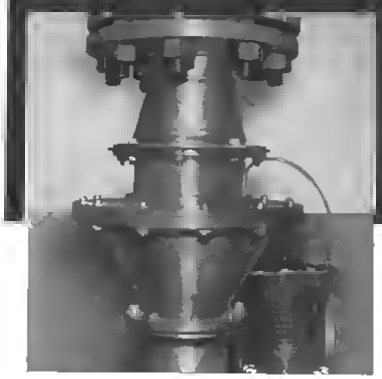
TO MEET THE LIFE SUPPORT REQUIREMENTS of long-duration space flights, a comprehensive, regenerable environmental control system will be needed. The primary design parameters: extreme reliability plus simple modular construction for easy maintenance. In addition, minute flow rates of liquids and gases must be metered under zero gravity conditions . . . improved components must be developed to prevent even infinitesimal leakage . . . proven techniques in systems dynamics and integration must be applied to assure dependability.

the breath barrier...

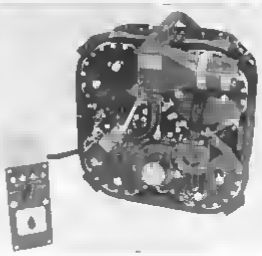
CURRENT HAMILTON STANDARD WORK in space life support is based on the use of many components which are presently within the state of the art. The entire space environment control system design includes . .

- a complete thermal control subsystem which utilizes a liquid heat transport loop and space radiator.
- a contaminant and trace gas removal subsystem, utilizing conventional filter techniques, regenerable and expendable solid absorbents, and a variety of catalytic oxidizers, for removal of noxious and toxic gases.
- a partial and total pressure-control subsystem, operating from cryogenically stored fluids to provide a normal environment without special clothing.
- high efficiency, low-speed fans with reduced noise level and inherently high reliability
- instrumentation for monitoring and controlling all significant variables.

IN AN INTENSIVE PROGRAM begun over four years ago, Hamilton Standard has already developed, built, and tested most of the basic equipment to be used. Moreover, a vast pool of fundamental research data has been accumulated which will greatly facilitate production of the system. This work is a logical evolutionary extension of experience that Hamilton Standard has amassed in the production of ECS for such advanced aircraft as the F-104, B-58, and B-70 —the most comprehensive system ever developed for manned flight.



WATER SEPARATOR controls humidity in closed, weightless environments by separating water from air. Integrated with space capsule air-conditioning equipment, the unit would apply centrifugal force to remove excess moisture from a controlled air supply and then pump it to a storage vessel.

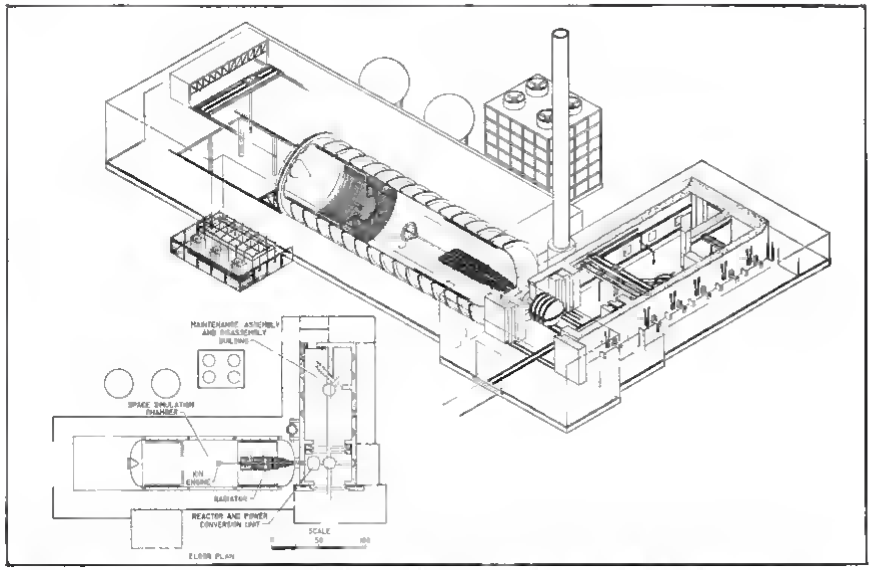


CO_2 REMOVAL UNIT could, in present form, sustain three men in a sealed capsule indefinitely. Several of these units have already accumulated hundreds of hours of testing. One assembly has completed a 30-day endurance test under a three-man load at space cabin conditions. It is now at NASA for further testing.

MOON ROOM, a 550 cubic foot closed environment laboratory, simulates isolated-cabin conditions for up to five men. Here, Hamilton Standard has performed development tests involving weight, configuration, volume, power requirements, and reliability of a variety of space ECS equipment.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT

AEROSPACE & INDUSTRIAL ENGINE CONTROLS • ENVIRONMENT CONDITIONING SYSTEMS • GROUND SUPPORT EQUIPMENT • TURBINE STARTERS
SOLAR POWER GENERATORS • STATIC POWER SYSTEMS • AUTOMATIC STABILIZATION SYSTEMS • ELECTRON BEAM MACHINES • PROPELLERS



MAJOR NEW PROJECT planned at Plum Brook is this $25.5 million space propulsion research facility, in which complete power generation and electric propulsion systems will be evaluated in start, throttling and shutdown. Flight-type nuclear reactor will be housed in the heavily-shielded compartment at the right front part of the facility

system capable of heat loads up to 400F.

Justification of this project stems from the increased use of hydrogen as a propellant in nuclear and chemical rockets, and insufficient knowledge about heat transfer characteristics of this propellant.

Modernization and reconditioning of Plum Brook service facilities, to cost $1.5 million, will provide for extending utilities, railroad repairs, road repairs, decontamination and demolition facilities, and repairs to several of the station's buildings.

At Wallops Station, $2 million is requested to modernize range control, range safety and support systems, which includes general launch support equipment. Another $1.5 million is earmarked for an advanced data acquisition system by addition of a high gain, multiple-frequency automatic tracking antenna and related data handling equipment. The antenna will be 25 ft in diameter, and will be housed on a tower 60 ft high.

Another project at Wallops is construction of new vehicle checkout facilities and their associated equipment, to cost $800,000.

Largest project in the request for Goddard Space Flight Center is $7.5 million to expand the spacecraft operations facility by 70,000 sq. ft., with additional data reduction, control, computation and communications equipment required to accept and reduce data from more advanced scientific satellites.

Other major Goddard projects:

- **Launch phase simulator,** $3.9 million, designed to test relatively large spacecraft in realistic environments of temperature, acceleration and spin. Specimens of 10 ft dia. and 15 ft high can be tested on a rotating arm capable of 50g loads for 1,000-lb. payloads, and 30g for 8,000-lb. payloads. Vacuum of 10^{-8} and heat loads ranging from −150F to 212F will be simulated.
- **Conversion of the dynamic test chamber** to a space simulator, $3.3 million. Solar simulator will be installed and a cryogenic cooling system will be added to the facility. New instrumentation includes a vacuum system, solar optics and lamps, solar power supplies, starters and wiring, penetrations and plenum, cryogenic pumping system, and a heat transfer system.
- **Applied sciences laboratory,** $3.2 million, to house scientists who will conduct research on infrared radiation, cosmic rays, meteorites, solar physics, X-ray radiation, magnetic fields and other geophysical areas.

Special equipment included in this facility will be particle accelerators, leak detectors, mass spectrometer, vacuum and thermal testing tanks, balancing equipment and gyro and hydraulic test stands.

- **Tracking and telemetry laboratory,** $3.2 million, essentially a duplicate of the applied sciences laboratory in appearance. In it, studies will be made of optimum transmission, modulation and detection systems, low-noise preamplification systems, cryogenics for high capacity data reduction, spacecraft ground control, ultra sensitive antennas, optimum feed and multiple feed antennas, antenna drives, timers, and facilities for VLF propagation studies.
- **Development operations building,** $1.9 million, to provide 70,000 sq. ft. of floor space for a magnetic tape library, instrument load and repair facility, and a clean room satellite building facility.
- **Attitude control test facility,** $915,000, essentially a nonmagnetic area to develop techniques for attitude control for scientific and weather satellites. Magnetic signatures of large spacecraft will be determined, and instruments in spacecraft will be calibrated in this laboratory.

The largest Jet Propulsion Laboratory project requested for Fiscal 1963 is a $3-million engineering mechanics building, to consolidate space science division work now being conducted in five trailers.

A $2.9 million telecommunications laboratory is being requested for the same purpose—to consolidate into a single laboratory office building work being done in trailers and old buildings.

NASA is requesting $2.4 million to build a data operations and command facility to be used for digital and analog computers and operations and control centers for JPL's lunar and planetary missions. Pre-injection tracking data will be relayed from this point to the deep space network, and the transit trajectories for lunar and planetary flights will be computed here.

Other JPL projects are addition of 20,000 sq. ft. to materials research laboratories to provide facilities for studying materials in high vacuums and under radiation and particles environments, $610,000; addition of 18,000 sq. ft. to the fabrication services building, $605,000; a machine shop, welding shop, assembly room, metal stores room, tool crib and offices, and general extension of roads and utilities, $820,000.

The $14.3 million project to construct an advanced antenna at Goldstone will provide an 8-10 db. greater capability on the earth end of the deep space tracking network than presently exists.

The antenna will be 230 ft. in diameter and use a folded radio frequency feed system. It will operate on a band of 2,290-2,300 mc.

This advanced antenna has been under study and design for the past two years.

Research Facilities

New construction at NASA's four research centers will provide a number of new facilities for basic research and advanced development which in general are not keyed to specific projects. The basic research role has been a large part of the work at these centers since NASA's predecessor agency, the National Advisory Committee for Aeronautics, was established at Langley Field, Va., in 1917.

Projects at Langley this year involve requests totaling $20.5 million, the largest of which is a $12.4 million space radiation effects laboratory.

NASA has not selected a specific site for the laboratory, but intends to operate it in conjunction with several universities. It will be capable of simulating the high energy corpuscular radiations to be encountered by spacecraft. Two accelerators are included in the project.

- **Linear electron accelerator,** rated at 2.10 MEV, consisting of a 1,300 mc. L-band klystron and an accelerator waveguide. The electron beam can be diffused to cover a target 10 m. by 4 m., with maximum X-ray doses of 5 x 10^6 roentgens per min. and neutron production of 10^{13} per second.
- **Frequency modulated cyclotron,** a heavy ion accelerator, able to provide proton pulses to an energy of 600 MEV. Hydrogen and helium can be used as the ion source and the accelerated ions can be protons or deuterons. This cyclotron will require a magnet made of 2,500 tons of iron wrapped with 150 tons of oil cooled copper wire.

Vehicle antenna test building, to cost $1.7 million, will be built at Langley for general research and development of antennas to be used on space vehicles. It will include two test chambers, both without echo, with one used for 100 mc. 1 kmc. frequencies, and the other 1.80 kmc. In addition to general research on antennas, this facility will be used for research on the effects of the plasma sheath, which blocks communications during reentry.

Other Langley projects include $1.5 million for new equipment for magnetoplasmadynamics research; $1.4 million for a stabilization and control equipment laboratory; $997,000 for spacecraft component environmental test facility; $936,000 for a micrometeoroid impact simulator; $858,000 for an addition to the heating plant; and $760,000 to improve the arc chamber in the 10 mw. arc tunnel so that it can simulate reentry conditions for lunar and planetary return.

Stabilization and control laboratory will house inertial simulators which will test and evaluate NASA and contractor guidance systems and sensors for manned lunar flight rendezvous and docking operations. Optical sensing devices which could be used in a lunar orbit mission, also will be evaluated here.

The particle accelerator will consist of a high voltage Van de Graaff machine of 5.5 million volts capacity, an ion beam particle charger, and a sensor to count and measure velocity of the particles. One-micron charged tungsten particles can be accelerated to a velocity of 80 fps. in the proposed accelerator, and 10-micron particles can be accelerated to 30,000 fps.

Vacuum Chambers

Environmental facilities to test spacecraft components will be a variety of vacuum chambers ranging in capacity from 1.50 cubic ft. They will be capable of pressures below 10^{-4} mm. of Hg. Support equipment will include ultraviolet and solar thermal radiation simulators, and static and dynamic structural load simulators.

The major project at Ames Research Center is a $9.8-million space flight guidance research facility, essentially a centrifuge large enough to hold a representative three-man space capsule and to obtain data for the integrated design of the guidance, stabilization control and crew support systems of the capsule.

The centrifuge arm will provide onset accelerations of 5 g/sec. to a 50g maximum, and will be able to maintain 50g loads at least 10 min.

NASA looks to this facility for realistic examination of the interrelationship of mechanical, electrical, optical and physiological systems of the Apollo spacecraft under all flight conditions except weightlessness.

Other Ames facilities include the following:

- **Radiative heat system,** to be added to the existing mass transfer facility, $2.2 million. This system consisting of high-intensity electrical arcs and imaging optical systems, will be used to evaluate 6-in. diam. test specimens of heat shield materials for lunar and planetary reentry vehicles.
- **Mach 50 helium tunnel,** $1.5 million. This will be a blowdown type tunnel with a 48-in.-dia. test section, able to test at Reynolds numbers from 0.1 to 4 million. It will be capable of producing 10 60-sec. runs, or one 10-min. run, before a three-hour pump time is required to refill storage vessels.
- **Bioscience laboratory,** $924,000, which is NASA's first in-house bioastronautics research facility. It will be used for research in immunology and genetics, radiobiology and exobiology. Specific programs include effects of irradiation on genetic systems in bacteria, fruit flies and inbred mice; effects of the space environment on genetics, reactions between ionizing radiation and living materials, and analysis of organic materials found in space.

This facility will consist of an office laboratory of 26,900 sq. ft., and associated laboratory equipment.

Lewis Construction

The single facility planned at the Lewis Research Center in Cleveland is a development engineering building, to cost $4.7 million, and considered necessary to house 1,250 new employees who will be hired between now and the end of Fiscal 1963. The building will consist of 171,000 sq. ft. of office space.

Two projects are requested at Flight Research Center: expansion of office and shop facilities to support the Dyna-Soar program, to cost $1.3 million; and installation of a visual flight simulator, $475,000.

The flight simulator takes into account the probable heavy reliance of advanced aircraft and spacecraft pilots on outside visual stimulus. This simulator will be used for research in landing and recovery, navigation and energy management. The simulator will consist of a projection system capable of a bright, controllable, wide-angle presentation of earth and sky, a cockpit, indicator controls with the capability to interchange pilot displays, fields of vision and controls, and associated electronic equipment.

Completing the list of 91 new facilities planned by NASA in Fiscal 1963 are four widespread tracking and data acquisition facilities, and $10 million

for designing high priority facilities which are not included in the Fiscal 1963 budget.

The tracking and data acquisition projects total $19.5 million and include:

- **Far East data acquisition** station, $6 million. Precise location of this facility has not been selected, but it will be in the northern latitudes and will be the companion station to the one now under construction in Rosman, N.C.
- **Rosman data acquisition** station, $3.5 million, for a second antenna system.

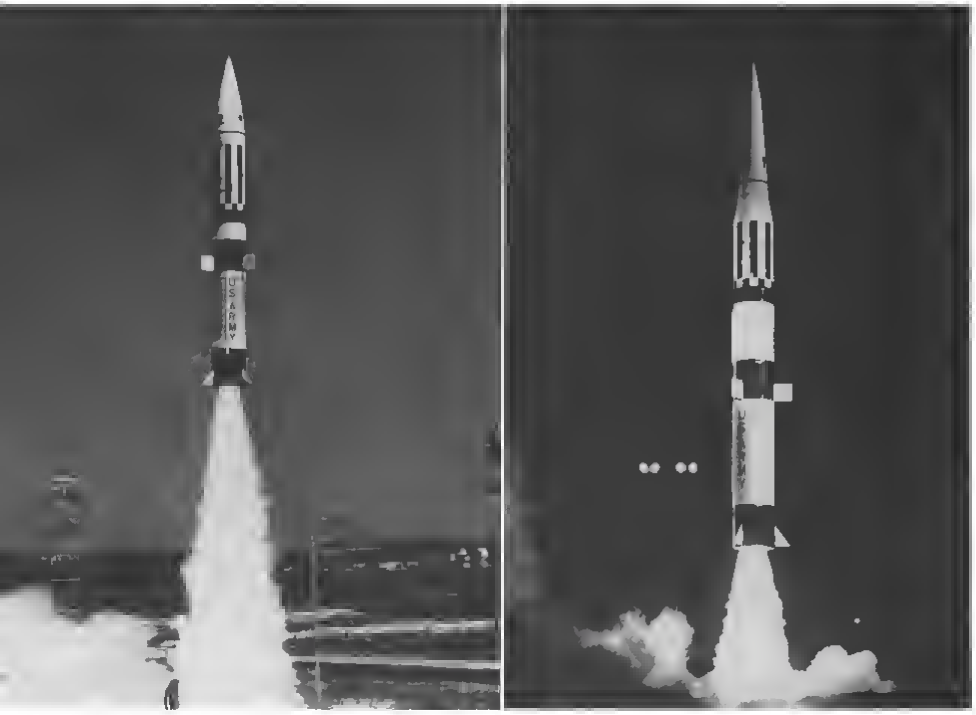
Both facilities are essentially the same and will be used to track geophysical and astronomical observatory satellites. Antennas for both will be 85-ft. parabolic prime-focus-fed dishes able to be converted to Cassegrain feeds. They will track on the 136–400, 1,700 and 2,290 mc. S bands.

Physical facilities at the Far East station will consist of a 12,800 sq. ft. operations building and two collimation towers. At Rosman, 6,000 sq. ft. will be added to the operations building and a second 85-ft. parabolic antenna system constructed.

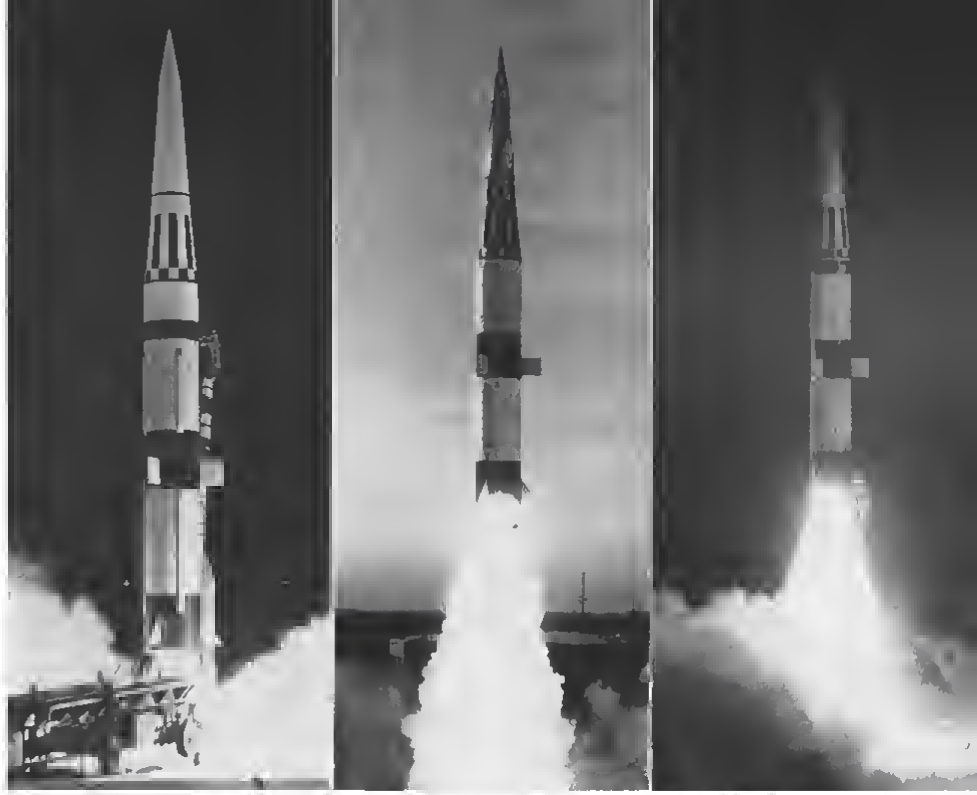
- **Antenna systems at Johannesburg**, South Africa, and Woomera, Australia, $5 million each. These identical systems are 85-ft. parabolic antennas considered necessary to assure full-time coverage of Mars and Venus missions planned in 1964. They will supplement current deep space net facilities and will permit tracking of two planetary payloads expected to be in flight concurrently.

New SINS Gyro Tested

Hydrogen gas-bearing gyroscope, expected to improve Polaris submarine SINS inertial navigator accuracy by several hundred per cent has been undergoing sea trials on the Ethan Allen. New Mark 1, Mod. 2 gyro, built by Sperry Gyroscope operates with clearances of 50 micro-inches between rotor shaft and journal bearing. Despite improved accuracy, new gas bearing gyro is less costly than predecessor which used ball bearings, Sperry says. New design also is expected to have greater longevity.



THIRD PERSHING launched (left) and 12th round (right) show external differences between first two groups of missiles



CONFIGURATION CHANGES show in rounds 20 (left), 29 which has a near-tactical shape, and 32, fired in driving rain.

Tight Control Keeps Pershing Program on Schedule

By David A. Anderton

Orlando, Fla.—Successful rainy night launching of a "near tactical" Army/Martin Pershing ballistic missile—32nd in the test series and most recent round to be fired—signaled a major step in the development program of this field army support weapon.

Two factors made that firing, number 32 in the Pershing program, different from its predecessors. First the missile and its basic ground-support equipment were in the "near tactical" configuration. Second, the environment underscored the ability of the Pershing to operate in the field under at least one adverse-weather condition.

Pershing was fired from the mobile erector launcher mounted on the XM-474 tracked prime mover. It used its own integral fire-control equipment to check the missile before launching. It was fired by the field manual, in as close a simulation of field conditions as has yet been achieved in the program. But the firing button was pushed from the blockhouse, and not from the sandbagged foxholes that are ready at the site when range safety will permit their use.

The rain was so severe that range safety considerations forced holds in the schedule because of limited local visibility. Downrange the weather was excellent so when there was a brief letup in the heavy cloud the countdown was completed and the Pershing blasted upward through a tropical downpour.

Neither Martin nor the Army has made much of this extremely significant environmental test of the Pershing system. There is probably no other ballistic missile, with the possible exception of German V-2 weapons operational during World War 2, that has ever been fired in a hard rain. The firing was successful, and there was no trouble with any of the tactical equipment on the site, due either to the weather or to other factors.

Configuration of Pershing 32, called "near-tactical" by the Army, used the minimum-length, 16-in. instrumentation and range safety section built into the missile. This I&R package is made in two lengths—16 in. and 48 in.—and is installed as an added body section behind the guidance section as required by the mission.

Pershing firings have been at the rate of more than one per month since the first launching in February, 1960. The firing program has been described—not alone by Martin but by military and other industry sources—as having the best success record of any missile fired at Cape Canaveral, or any other known range, for that matter. This takes in a large variety of weapons and a 12-year time span.

Paralleling the firing program at Cape Canaveral is the training program which has been under way for some time now. More than 200 officers, enlisted men and civilians have already graduated from instructors' school operated here at Martin Co.'s Orlando Division. User schools are scheduled to begin soon at Army installations.

The first complete set of training equipment has been received, ahead of schedule, at the Army's Artillery and Missile School at Ft. Sill, Okla.

Production of the Pershing is increasing toward scheduled figures which are high for missiles of this type and Army is looking forward to receiving its first sets of operational equipment and missiles which will mark the entry of the weapon into military service.

Pershing was developed as a mobile,

TRANSPORTER-ERECTOR-LAUNCHER for Martin/Army Pershing is self-propelled vehicle.

lightweight weapon system for support of field armies. It can move by road or overland in a convoy of four tracked prime movers by helicopters, in the holds of several Boeing Vertol HC-1B Chinook helicopters, or by airlift, in the bellies of USAF cargo carriers to more remote sites.

The weapon system is expected to operate over almost any kind of terrain and in any kind of weather or climate. It was planned to have a quick reaction capability, to be able to arrive at a site, set up and fire, and move out again in minutes in an application of "shoot-and-scoot" techniques.

Pershing is a two-stage solid propellant type of missile, with selective range capability determined in advance by target conditions. It is to replace the Chrysler built Redstone missile now long since deployed with Army units. Maximum range of the Pershing is 400 naut mi carrying a nuclear warhead.

Primary arm of the Martin Pershing team, headed by program director Herman Staudt, was to develop a simple missile for high reliability, easy logistics, and sure-fire operation by a minimum number of troops. On top of this conceptual philosophy was the management philosophy of the Orlando Division, now headed by G. T. Willey, who runs a tight shop. The final product of these two philosophies is a weapon system that has been on schedule more than 90% of the time, and that is within a fraction of a per cent of its original cost estimates.

Pershing contract, signed on Mar. 28, 1958, marked a shift in Army procurement procedures away from the "arsenal concept" (AW Mar. 31, 1958, p. 19, Mar. 23, 1959 p. 59). Martin's performance answers critics of the Army's traditional rigidity in contracting, and educates some of those within the Army who still believe the arsenal concept is the Army way and therefore the only way.

The missile itself has a 40-in. dia body made up conventionally of warhead, guidance, second- and first-stage propulsion, starting at the top and working down. Overall length varies with the current test mission because of an extra instrumentation and range safety package installed as a body section just below the guidance.

In the closest approach yet to a tactical configuration, the 29th Pershing to be launched did not carry even the minimum-length I&R package. Its length was about 390 in. (32.5 ft.).

Both stages have aerodynamic control surfaces combined with jet vanes in the exhaust. The aerodynamic controls on the first stage body are double-wedge delta-plan airfoils, and those of the second-stage unit are single-wedge with rectangular plan. These controls are made from a foam-filled glass fiber layup. Jet vanes are molybdenum. Both surfaces and vanes work together on shafts with a common centerline; there are three each of both surfaces, spaced at 120 deg around each stage.

Both stages have solid propellants developed and produced by the Thiokol Chemical Corp. They are housed in casings made of precipitation-hardened stainless steel.

Above the second-stage housing, and ahead of the I&R package installed in test rounds, is the guidance system housed in a truncated conical section. It is an inertial system, developed and produced for the missile by Bendix Eclipse Pioneer Division.

Topping the Pershing is its re-entry vehicle, a new shape with higher impact velocities than any other current type. The accuracy and precision requirements laid down for Pershing demanded that the warhead spend as little time as possible on the downward leg where it could be affected by atmospheric winds. This in turn demanded a high speed re-entry with drastic heating all the way down, and dictated an ablative material for the surface.

Fuzing and arming the warhead, a critical part of any weapon system involving nuclear explosives, is done by a system produced by Ford Instrument Co. and Sperry-Farragut, both divisions of Sperry-Rand. Original major subcontractor on this system was Bulova Research Laboratories.

The Pershing missile, minus its warhead, is mounted on a mobile erector-launcher unit originally designed here, developed by the Tapco group of Thompson Ramo Wooldridge, Inc., and now produced by the Armament Division of Universal Match Co. Prime mover for the system is the XM474 tracked vehicle, modified from a light armored personnel carrier.

The Pershing round is cradled in an erector boom, and held in place with clamps. First stage of raising the missile takes it within five degrees of the vertical. Power for that operation, as well as for raising the integral umbilical mast, comes from an 11-hp. electric motor. The last five degrees of erection is done with a 3-hp. motor.

The erector-launcher weighs about 5,800 lb., and is about 20 ft. long, about six feet, six inches wide, and about nine feet high over-all. The XM-474 vehicle, built by FMC Corp. has power train and suspension identical to those of the M-113 personnel carrier. It has a 200-mi. cruising range, and a maximum forward speed over the road of 40 mph. It can ford a 42-in. depth of water, and can be made amphibious with a special adaption kit. It is about 18 ft. long, 8 ft. wide, and weighs about 24,000 lb. gross.

Second unit in the train carries the warhead in a clamped cradle.

The third holds two small enclosures. First is the power station, a compact

Partial List of Pershing Wind Tunnel Tests

Description of Test	Test Facility
Three-component pitch data	ABMA 14-in. x 14-in.
Base force test	ABMA 14-in. x 14-in.
Air vanes force test	ABMA 14-in. x 14-in.
Complete and second-stage configuration	AEDC Transonic Model Tunnel
Re-entry body dynamic test	AEDC Transonic Model Tunnel
Re-entry body force test	AEDC Tunnel E-2
Air vanes force test	AEDC Transonic Model Tunnel
Complete and second-stage configuration force test	BRL Aberdeen Supersonic Tunnel
Complete configuration and air vanes deflection force test	BRL Aberdeen Supersonic Tunnel
Complete and second-stage configuration roll tests	JPL Supersonic Tunnel
Re-entry body and second stage configuration force test	NOL Hypersonic Tunnel
Re-entry body pressure test	ABMA 14-in. x 14-in.
Re-entry body pressure and force test	AEDC Tunnel E-2
Second-stage configuration force test	AEDC Tunnel E-2
Double-wedge aft vane panel model force test	AEDC Transonic Model Tunnel
Bi-convex aft-vane panel model force test	AEDC Transonic Model Tunnel
Re-entry body low-density force test	U. of Calif. (Berkeley)
Second-stage configuration tail heating hot-jet test	NASA Lewis Lab. 10-ft. Unitary

Abbreviations: ABMA—Army Ballistic Missile Agency; AEDC—Arnold Engineering Development Center (USAF); BRL—Ballistics Research Laboratory (Army); JPL—Jet Propulsion Laboratory (NASA); NOL—Naval Ordnance Laboratory

unit which mounts a gas turbine to power an a.c.-d.c generator, to supply compressed air for umbilical separation and to supply compressed and conditioned air to other areas as required. Second unit is the programmer test station, actually the blockhouse, containing checkout and test equipment, computers for programming missile guidance and automatic systems for preparation of the Pershing missile for firing.

Fourth of the vehicles carries the communications central, the AN/TRC-80 tropospheric scatter terminal built by Collins Radio Co. for communications between the Pershing battery and headquarters, and between elements of the battery. The antenna is air-inflatable and is normally carried in a stowed position. Inflated, it is eight feet in diameter. The shelter is about eight by six and one-half by five and one-half feet, and is built of aluminum shell construction with a glass fiber interior reinforced by foamed plastic.

Two men can put the communications unit into operation within 10 min. after arriving on the site. This is the time constant for the entire system, a Pershing battery arriving on a selected site can be ready to fire in about 10 min.

The non-wheeled items, such as the communications shelter, power station and programmer test station, are normally carried on prime movers in the roadable form of the weapon. If the system has to be air-lifted, either by helicopter or fixed-wing aircraft, the shelters are made mobile with a removable wheeled gear and must be towed or otherwise moved around with separate vehicles.

Pershing originated in a study made jointly by Department of the Army, U. S. Continental Army Command, and the Army Ballistic Missile Agency. It was one of the series of four—Missile A, now dead or dying; Missile B, about to become a program, Missile C, the Sperry Sergeant; and Missile D, the Pershing—missiles intended to meet the needs of field armies of the future.

Seven companies bid for the prime contract, and Martin won the competition.

ABMA was directed to do technical supervision, and contract administration was assigned to Birmingham Ordnance District.

On Mar. 28, 1959, one year from the date of contract, the first Pershing was delivered to ABMA for static test and captive firing. First free firing was at Cape Canaveral on Feb. 25, 1960. That one, and all firings since, used the erector-launcher instead of the more-conventional firing stand.

Flight test program called for six firings of incomplete missiles to prove structural reliability and performance of the first-stage motor only. Sixth of the firings was made from the erector-launcher mounted on a tracked vehicle to start proving out that portion of the system.

The second group of flight-test missiles used the long I&R section, and were to check stage separation and second-stage ignition. Eight missiles in this group were fired, for a score of six unqualified successes, one failure and one partial success. The latter met 70% of its test requirements.

Phase Three Tests

Third phase of flight testing began Apr. 21 last year, with a successful firing of the Group 3 configuration. These missiles were characterized by a different warhead shape, improved motors in both stages, and internal changes including a modular hydraulic system. Both minimum and maximum length I&R packages were attached to missiles during the Group 3 firings, which are still proceeding.

A hint of the fourth phase was given in firing 29, a Pershing completely lacking an I&R package, and therefore being the closest approach to a final tactical configuration. More of these will be launched in the future, intermingled with the Group 3 missiles.

Current box-score of the Pershing firing program shows a total of 32 rounds. One of these was a complete failure and three have been partial successes.

Under Staudt as Pershing program director is the engineering organization headed by H. Clay Johnson, technical director of the Pershing project. Johnson, whose background includes previous positions as project engineer for Lacrosse and department manager for aerodynamics and mechanics, supervises three project sections, each headed by a project engineer. The three sections—system, missile and ground-support equipment—handle the portions well-described by the titles. There is a total of about 1,200 technical personnel in the three groups, with about 35% professional people and the remainder draftsmen. Johnson says the project is close to being properly manned, but admits he could use a few more engineers particularly technical programmers.

He also detailed the wind-tunnel test program for the Pershing missile (see box p. 83).

Pershing Programing

Plans and programing for Pershing production starts in the group headed by John W. Sears, and uses as its basis the contract numbers specified by the Army. Martin Orlando's basic planning philosophies are the guide lines for Sears and his group of about 40 specialists.

Five of this group are planners who work very closely with the engineers on the Pershing project. This is the level where control of planning starts, according to Sears, "The basis of control is truth at the bottom layer." Random sampling approaches contribute further to control—which is interpreted here to mean matching the plan—and by other conventional planning and monitoring techniques.

Brief status meetings are held every two weeks, with the "pie chart" situation report as the basic document for each meeting. These situation reports are prepared 24 hr. in advance of the meeting and each indicates any critical areas where control might be needed.

In effect, this system uses the technique of management by exception, rather than step-by-step scrutiny of every move as it happens. This approach saves time and money, because there is no need to worry about items which are on schedule and going well.

Sears' group processes about 700-800 change orders each week, and perhaps five or six delinquencies. These latter few items draw the spotlight of the planners' attention and point the way toward work that must expedite.

Differential between actual and estimated costs is about ½% across the board at the Orlando Division. Pershing finance manager Walter C. Uber has the problem of helping to keep that figure. His approach is the expected one: estimate the costs properly first and then control them strictly afterward. This reaches down through in-house production to the subcontractors' plants, where Uber's men monitor the cost-control programs of these major vendors.

Other financial experts sit in Pershing procurement, under Philip E. Kerns, Jr., checking costs then against the original estimates. Kerns' whole group is assigned only to the Pershing rather than being split among the several house programs at Orlando. They also work as teams with the financial people out at major subcontractors' plants, such as Eclipse-Pioneer and Thiokol.

The procurement system here differs in detail from many in the industry. Design engineers furnish an advance information sheet which defines the specifications for each part to be procured and suggests possible vendors. Procurement personnel then locate the sources and receive their bids. Holding back the bid figures, they then ask the engineers to choose among the proposals on a technical basis only, with out knowledge of the cost. If cost figures are within the estimated values, the technical manager gets the order. If they are not, then there is some give-and-take between engineering and procurement.

Once Pershing is out of research and development work and into production, it is probable that a second source of supply will be needed, either as insurance or in response to a customer demand. Consequently, all engineers are asked to specify an alternate source for each part when they make their first choice in the evaluation of bids.

Quality Control

The proud boast of Orlando's Quality Control Dept. is that there has never been a workmanship failure in the Pershing flight test program.

This is one result of a stringent code of quality control established by the department under Philip B. Crosby. His viewpoint is that there are only three types of failures possible in design, in workmanship and in the components themselves. Design and workmanship failures are controllable, he argues, so we should only experience component failures.

One of the ways to minimize component failures is to test every one, not just a random sampling, as it comes from an outside vendor. This program is in effect on the Pershing, every part bought outside is checked on a go, no-go basis before being cleared to the manufacturing department. Beyond components, nothing comes into the plant unless it is quality-controlled, Crosby emphasizes, and that starts with raw material.

Quality control of soldering techniques provides one example where Crosby's group works with manufacturing, under William Sykes. It starts with the screening of applicants for the job, and continues through what amounts to an apprenticeship period. At the end of this trial time, the worker is either kept or released.

Statistical analysis of soldering work has shown that about 10% of the workers make about 90% of the errors. But speaking in percentages like that tends to give an erroneous impression of the rigidity of the quality control program here.

Martin is working to what the military generally recognizes as the toughest soldering specification: Army's PDS 1C. It allows one Class A failure per 20,000 soldered joints. Class A failures are either loose or unsoldered connections. Class B is a cold solder joint, and Class C is insufficient solder.

The company is shooting to beat the Army's Class A requirement by a factor of five by reducing the failure rate to one in 100,000 joints. The approach is multi-pronged, but perhaps the most effective reminders of the need for quality control in the work are the large signs that hang above each section of the shop where soldering is done. They show the progress in reducing the number of joint failures, plotting this month's failure rate against two lines: the Army's acceptance rate and the Martin desired value.

Sykes said failures dropped the first month the signs were up. Departments didn't want the blazon of inefficiency hanging over them. Since then the trend has been generally and steadily downward. Failure rate is currently below the Army's acceptance level in most cases.

He also said that work centers are expected to show performance increases every week, both in cost and output, twice-weekly meetings check and report this progress.

Final proof of the effectiveness of engineering, manufacturing and quality control departments comes in the reliability and systems test work done by a group headed by Nicholas de Pasquale.

"Reliability is not a paper figure here," he emphasizes. "It's a test value."

The group works in three areas: basic to Pershing design and production, reliability and test evaluation, qualification testing, and system and subsystem test.

First of these is tied closely to the engineering of the missile system. Reliability and test evaluation includes design analysis and failure analysis to pinpoint possible trouble spots before they occur. Reliability assessment and education grow directly out of these approaches. The test data reduction and analysis is also part of the responsibility of de Pasquale's group.

Qualification testing begins with the availability of parts in their finished form. The 400 technical personnel in

NATO Bullpup Plan

Paris—Final details involving a NATO-sponsored European production program of the Martin Bullpup air-to-ground missile have been approved by the four participating NATO nations (AW May 26, p. 21).

Program is expected to be ratified by the top NATO council in a few weeks. Nations involved are United Kingdom, Denmark, Norway and Turkey. Norway has been selected as the prime contracting country. U. S. involvement will be mainly one of technical aid.

Once the NATO council formally ratifies the project, NATO will create a special agency to be called the NATO Bullpup Production Program. This agency then will deal with companies involved in the program including the as yet unnamed Norwegian prime contracting company.

NATO sources indicate dollar value of the Bullpup program will be around $40 million. European-produced Bullpup will be the version currently in operation with U. S. Navy.

the group qualifies all parts and components in this phase of their work, they test units to failure, and perform pre-flight certification of other portions of the system. They work on standardization of parts, and furnish support to customers and liaison with subcontractors.

But most of the workload comes out of the system and subsystems tests, including these regimes for the Pershing missile:

- **Aberdeen Proving Ground road test.** This is the road test for all Army vehicles, including tanks and prime movers. The four tracked vehicles of the Pershing system were put through a 4,000 mi. endurance run there.
- **Naval Air Materiel Center** temperature and altitude tests.
- **Army Ballistic Missile Agency** temperature tests.
- **Age and deterioration tests.**
- **Eglin AFB low-temperature tests,** in the climatic hangar.
- **Three remote on-site tests** tropics, desert and Arctic.
- **Captive tests.**
- **Service test program,** actually the first user test run by Army.
- **Flight test support,** during the development launching program.
- **Local weapon system test,** which is a checkout of missile modes and a check of the reaction times run at Orlando.
- **System test laboratory,** where the complete Pershing system is linked to an analog computer to determine the response to programed data.
- **Industrial test plan,** which occurs after activation of the Pershing. This plan calls for product improvement program cost reductions etc.

Logistics Backup

Finally, the system is of no value in the field unless the handbooks are there, unless there are repair parts as needed and unless there is a complete logistic system backing up the operations. Pershing's logistics manager, F. G. Foster, says that right now handbooks are in the form of research and development notebooks—"good looking books, varityped and with pictures"—for the training program. The Army Artillery Board, which will actually be the first user of the Pershing end product will get complete final-form handbooks.

Lack of repair parts has never held up a Pershing schedule, Foster says. There is one inviolable rule in the handling of repair parts: unless a failure report comes along with the failed part, there is no issue of the repair part. The reason behind this is plain: service trouble reports, fed back to engineering and production departments, are invaluable sources of information. First, they point out immediate troubles, second they locate possible areas where trouble may be expected. And third, if there is any pattern to the failures, it becomes obvious, but this third factor generally takes about 12-18 months after the user begins operations.

Firings of the Pershing at Martin's VLF-30 (Vertical Launch Facility) are under the direction of Stanley A. Welsh, director of Pershing operations for Martin's Cape Canaveral Division.

Welsh and his 40-man firing crew work at one of the simplest firing sites in the missile business. There are two pads, a surface blockhouse with a second story observation area, and a missile assembly building. A single gantry completes the physical facilities at the site.

But long ago the gantry was wheeled out of the way and hasn't been touched since. Welsh says they don't need the missile assembly building any longer, either. "This is not a modification center," he points out. He admits to one or two component failures in missiles, found during the incoming inspection, but adds that they were failures that could be handled under field conditions.

Starting early in the first group of missiles, fixed firing platforms were eliminated in favor of tactical-type equipment. As the development program moved along more and more elements of field equipment were integrated into the firing sequence. On Mar. 15 Pershing was launched in a simulated tactical firing using basic equipment.

The firing program will continue at Cape Canaveral, and will go from the current launchings of "near-tactical" configurations to actual tactical weapons, complete with all field equipment, and less only the nuclear warhead. There will be a gradual changeover to Army firings under Martin monitoring and, finally, to all Army shots.

The first complete set of Pershing training equipment was airlifted from Orlando by Douglas C-124 aircraft to Ft. Sill, Okla., and there it was unerated and spotted in the checkout area during a two day period.

Inspection and orientation on the training gear was held the third day, there were no deficiencies, no parts needing replacement, and not even a scratch on the paint. By late evening of the third day, the entire system had been checked, several countdowns completed, and the training equipment was declared ready to turn over to the Army. Seven Martin technicians did the checkout operation, under the direction of Marvin Colvert from Foster's logistic support group.

The near future will see the separate tracks of Martin test firings and Army training approach and finally converge when Army has taken over the Pershing as an operational weapon. During this year, significant progress will be made toward Pershing's eventual replacement of the Redstone missile.

USS Enterprise, world's first nuclear-powered aircraft carrier, has relatively small island devoted largely to electronic gear.

Antenna Arrays Dominate USS Enterprise's Island

New AN/SPS-32 and AN/SPS-33 surveillance radar antennas, looking like white signboards immediately below the glassed-in areas of the island in top photo, are placed side by side with a pair of each located around the four quadrants of the island. The new radars, developed by Hughes Aircraft Co., are the first shipboard antennas to use electronic scanning, eliminating the need for large, exposed, rotating antennas and permitting a higher scanning rate. The radars provide full 360 deg. azimuth coverage and about 60 deg. elevation coverage. Close-up of island, below, with Chance Vought F8Us in foreground, shows turret-shaped array of canted UHF antennas of the Navy Tactical Data System. System provides communications between ships with a task force, exchanges radar and computer data between ships and automatically directs carrier-based interceptors to targets much like the Sage air defense system data link directs Norad fighters automatically. Turnip-shaped object atop the mast is a tactical air navigation (TACAN) antenna. F8U Crusader parked near crane immediately forward of island was first aircraft to come aboard.

Competition Slashes Sidewinder 1-A Price

By Philip J. Klass

Utica, N. Y.—Price of the Sidewinder 1-A missile guidance and control unit, heart of the Navy developed air-to-air missile used also by the Air Force and NATO, has been slashed nearly 70% in six years since the Bureau of Naval Weapons brought in second source competition.

The competitor was General Electric's Light Military Electronics Department here, and the original supplier was Philco, now a division of Ford Motor Co., Philadelphia.

The Navy hopes for a similar payoff on its Bullpup air-to-surface missile as a result of last year's action in setting up Maxson Electronics Corp. as a second source to Martin Marietta/Orlando, which developed and first produced the missile. Another example was Navy Special Projects Office decision to set up Minneapolis-Honeywell and Hughes Aircraft Co. as a second source producer of inertial guidance for Polaris missiles. Initial source was GE's Ordnance Department.

A similar competition is planned for the new longer-range Sidewinder 1-C when it goes into production. Although both GE and Philco are expected to be strong contenders, the Sidewinder 1-C production is expected to be thrown open to wider competition, according to Capt. Charles D. Mott, chief of BuWeps Missile Astronautics and Ammunition Division.

Basic Concept

The basic philosophy, which BuWeps pioneered with the Sidewinder 1-A, calls for setting up a second source after the basic design has been established and the weapon has been in production for about a year. The Navy underwrites the cost of the second source's special tooling and gives it a small pilot quantity contract. Thereafter, the two companies compete for subsequent years' production to determine which will get the major portion of the total production quantity.

Eight companies were finalists in the second-source competition for the Sidewinder 1-A, according to R. C. Wales of the BuWeps contracting group.

Multiple source bidding long has been used for products which can be adequately defined by specifications and drawings, but the Sidewinder 1-A represented the first BuWeps attempt to apply it in the missile field to something as complex as the guidance, control and airframe system.

While Sidewinder cost has been coming down, its reliability has been going up. In part, this improved reliability stems from design improvements devised by the two companies to reduce complexity and reduce manufacturing costs.

Sidewinder was developed by the Naval Ordnance Test Station (NOTS), China Lake, Calif., as a marriage of an infrared guidance head to a five-inch unguided air-to-air rocket. Philco was brought into the program as the missile neared the production design phase. In Fiscal 1955, the company received a pilot production contract for about 300 of the missile guidance and control heads. The initial production price was about seven times the current figure.

The guidance and control head contains the infrared scanner, detector and amplifiers, gyro stabilization, control surfaces and associated hot gas servos. In addition to this subsystem, Navy buys the warhead, fuze, safety and arming, rocket motor and wings, on a low-bid basis, then assembles them all into a complete missile.

In Fiscal 1956, GE received its first Sidewinder production contract for a small quantity, while Philco, then in its second year, received the major share of that year's production. On the larger quantities, Philco quoted a price which was about one-third that of its previous year's pilot production run. GE's price was somewhat higher but less than the previous year's Philco price.

Intense Competition

The competition really got under way in Fiscal 1957. Both companies were asked to submit prices on a variety of different quantities. BuWeps then computed the most advantageous split of year's production, based on each company's pricing schedule.

The first year GE and Philco submitted quotations which were not too far apart, so production was divided almost

SIDEWINDER air-to-air missile guidance and control unit cost has been slashed 70% in six years through dual-source competition practice of Bureau of Naval Weapons.

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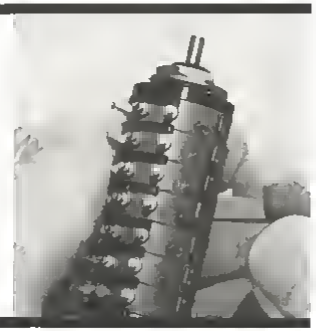

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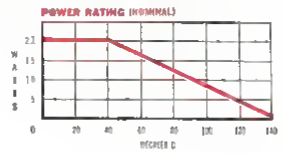

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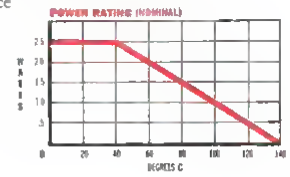

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equally with GE getting a slightly larger number. But in Fiscal 1958, a cost-cutting program at Philco had begun to pay off and the company came in with a figure considerably below GE's price and one which was only one-sixth of the Fiscal 1955 figure. Philco therefore received two-thirds of the year's production.

The competition see-sawed back and forth as each company sought to cut costs and to improve its manufacturing operations. By 1960 there was added pressure because it appeared that the Navy had acquired a Sidewinder 1-A inventory adequate for its own needs until the improved model 1-C came along and that in Fiscal 1961 the only production needed would be for Air Force and allied contracts. This indicated that only one of the two companies would be required for production after Fiscal 1961.

During the first several years of Sidewinder production, GE officials now concede, there were serious problems. Although the Sidewinder is considered a simple missile compared with other air-to-air weapons, it requires extremely high precision, close-tolerance work.

Rejection Rate

At one point early in the GE program, the company was experiencing a final-test rejection rate of 120%. That is, units rejected in final test and returned for repair often failed again to pass final test, perhaps for another reason. And some of these units returned for repair failed still again.

In 1959 Light Military Electronics Department initiated an all-out value-analysis program aimed at design improvements to ease manufacturing problems and lower production costs for the growing competitive battle with Philco. By June 1960 the results of this major product improvement program entered into Sidewinder production.

The initial results were so encouraging in terms of lower costs and higher reliability that GE was able to submit the lower bid for Fiscal 1961 production and it received the entire quantity for that year. Although the original number was modest, it has been increased significantly as a direct result of last summer's Berlin crisis.

Today, the going price of Sidewinder guidance and control units is only one-seventh the original Fiscal 1955 pilot quantity figure. Compared with the initial Fiscal 1956 high-production quantity cost, which is a more logical reference, today's price is only one-third, according to Mott.

When Navy selects a second source for a program such as Sidewinder and Bullpup, it insists that the new contractor develop a different group of subcontractors and vendors wherever practical. This assures that the cost-saving advantages of competition will accrue at several tiers in the production structure and not merely at the prime contractor level. Also, it broadens the industrial base and makes production less vulnerable to natural and man-made interruptions.

Capt. Mott emphasizes that the dual source type program is only one of several ways of introducing competition into Navy procurements and is not universally applicable to all types of procurements.

Navy Expense

The cost of setting up the second source, and the possible loss of economies that might be obtained if the entire quantity was produced by a single contractor are economic penalties. Additionally, the Navy must foot the cost of testing and qualifying the output of the second source.

Before a decision is made to go dual source, the situation must be carefully analyzed. Many of the factors involved are intangible or difficult to predict.

"If it takes more than three years for dual source procurement to begin to pay off in over-all savings to the Navy, its use is questionable," Mott says. "If it takes more than five years to achieve a net saving we won't touch it," he adds.

The problem of coordinating changes in design when there are two production sources is an old one. But when there is competition between them for the major share of production quantities a new potential problem area arises. Neither Philco nor GE could be allowed to introduce a design change into its own missile production which would affect interchangeability of major components between missiles made by the two companies, without creating logistic and maintenance headaches for the Navy.

But where such changes did not affect interchangeability, each company had to be given sufficient freedom for product improvement in its fight to lower costs and raise reliability. Such improvements had to be made available to the other company if it wished to incorporate them, but on an optional basis.

Design Changes

To provide the required flexibility with reasonable control, two types of design changes were defined, with two different procedures for carrying them out:

- **Minor** changes, which did not affect overall performance or interchangeability, and which contractor proposed to introduce at no cost to the Navy, required only the approval of the resident Naval Inspector of Material. Approved changes could be adopted by the other source at its discretion.
- **Major** changes, which did affect per-

formance, interchangeability and/or cost required approval by a special committee, consisting of representatives of BuWeps, NOTS, Philco, GE, the resident Navy inspector, Air Force and the Naval Ordnance Laboratory. Approved changes were mandatory for both companies.

Normally, this committee met once a month to review all proposed changes, regardless of their source. Usually, decisions to accept or reject were made on the spot. One meeting might take place at the GE plant here, the next at BuWeps in Washington, the next at NOTS in China Lake, and the subsequent meeting at the Philco plant in Philadelphia, according to Cdr. A. S. Knechtel, Navy inspector here at Utica.

Major Effort

As GE attempted to dig out from the reliability and manufacturing problems encountered in the early days of the program, it became apparent that no small handful of fixes would cure the rash of troubles, and that a major department-wide effort was needed.

The Light Military Electronics Dept. set up 100% inspection and test for every incoming part. It brought in vendors to explain the importance of the program and the need for extreme quality control in their plants. GE sent its own representatives to the vendor plants in a joint effort at product improvement.

Approximately once a week, factory workers on the Sidewinder line met in the cafeteria to listen to company officials a visitor from BuWeps, NOTS, or a Navy pilot who had used the Sidewinder.

Through such meetings the workers on the line learned of the importance of the program to both the Navy and GE, and the necessity for extreme care in manufacturing. A huge scoreboard, visible from most parts of the factory area, was installed to show shipments versus contract schedule. At Philco, a similar program was under way to enlist employee support for the competition.

As component quality went up, the 100% inspection was eased to controlled samples whose size and frequency went down if quality was good but increased if quality dropped, according to Robert H. Crip, LMED manager of Sidewinder quality control.

As LMED gained familiarity with the Sidewinder, it found it possible to zero in on the potential trouble areas and isolate them more quickly. For example, one frequent cause of failure in final test under vibration was the pre-amplifier. By setting up special vibration test equipment on the pre-amplifier assembly line, it was possible to weed out the defective units before they were installed in the guidance and control unit.

Where previously the entire guidance unit was subjected to cold exposure, analysis of test data showed the only problem area was binding of the scanner gimbal under such extreme temperatures. GE devised a far easier, less costly and less time consuming method for checking gimbal binding which did not require cold chamber use.

By late 1959, GE had slashed the final test rejection rate from 120% to less than 10%, AVIATION WEEK was told.

Meanwhile, both Philco and GE were searching for ways to slash manufacturing costs, both direct assembly and fabrication, and the indirect costs resulting from in-factory failures and rejections. Additionally, reports from the field indicated that despite Sidewinder's comparatively good reliability, there was room for improvement.

Both companies therefore launched value analysis programs. At Philco and GE, teams of engineers and manufacturing experts pored over every assembly, even subassembly, every major component, asking the eternal value analysis question: How can the design be simplified and/or the manufacturing process changed to reduce cost and/or improve reliability?

Experience at GE and Philco shows that reliability usually goes up as a result of design changes intended to reduce manufacturing cost, because such changes usually involve simplification and/or reduction in the number of individual parts in the assembly.

For example, the IR dome mounting ring for the Sidewinder originally made of stainless steel machined out of bar stock at a cost of about $45, was later made by precision investment casting for about $14. By the time GE's value analysts finished their product improvement, the mounting ring was being die cast from aluminum at a cost of only $2, with a significant weight reduction over the earlier steel rings. In addition to this 22:1 cost reduction, the skeleton form of the new ring simplified the potting of gyro precession coils in the seeker head coil assembly, to which the ring attaches, greatly reducing the number of potting voids and subsequent rejects.

The mechanical gyro caging mechanism, originally consisting of three individual metal rockers each with its own spring whose gradient and tension had to be carefully controlled, was a source of rejects in the factory and failures in the field. After redesign by GE engineers to use plastic rocker arms and a single garter spring, the cost of the caging mechanism was slashed by 76%. But this was only a small part of the payoff. The reliability of the device in the factory and field was improved significantly, the number of parts in the assembly was cut from 23 to 10, and the manufacturing and assembly procedure was greatly simplified.

A thermal protector, intended to interrupt current to an electric heater if its temperature became excessive due to a malfunction, originally consisted of a tiny snap switch mounted on a bracket with its contacts held in a closed position by a bead of solder through which the heating current passed. If the current became excessive, the solder was supposed to melt and release the snap switch, but it was difficult to control the manufacturing process for this assembly and impossible to test it without melting the bead of solder. To replace this assembly, GE selected a standard, commercially available spring-loaded fuse which cost only one-eighth as much as the original switch and which has proven far more reliable.

Through mechanical, magnetic and electrical redesign of a generator used to provide a.c. power for the Sidewinder, developed by an outside vendor, GE was able to cut cost by nearly 30% and simultaneously eliminate a source of unreliability in the original generator.

Philco's value analysis effort also was producing improvements in the missile design and the ideas of each group were made available to the other through the monthly committee meetings.

Cost Drop

Where originally the cylinder blocks for the four control surface actuators were individually drilled and honed, Philco found an improved automatic lathe and special alloy tools which permitted all four cylinder blocks to be shaped simultaneously. As a result, the cost of this vital assembly dropped from $65 to $18.

Originally Philco obtained the Sidewinder gyro from three different suppliers, but finally decided to set up its own precision machine shop to produce the units in an effort to reduce the number of gyro rejects. The in-house facility cut both rejects and gyro costs.

FILTER CENTER

► **Navy to Buy Molectronic Radio Sets**—Bureau of Naval Weapons is soliciting sources for upcoming program to develop and build 10 models of an air-sea rescue radio set capable of providing emergency two-way communications at 243.0 mc., using molecular electronic and thin film fabrication techniques. The tiny radio sets, expected to be the size of a package of cigarettes, will activate automatically upon parachute deployment of a crew member.

► **Thermoelectricity Boosted by Magnet**—Figure-of-merit of thermoelectric materials has been increased by as much as 150% under some conditions by subjecting the material to a magnetic field at right angles to the current flow, Bell Telephone Laboratories scientists have discovered. Using an alloy consisting of 88% bismuth and 12% antimony, operating at a temperature of 100K, and a magnetic field of 1,000 gauss, BTL scientists say they have achieved a figure of merit of 0.0086, the highest yet reported and about 50% higher than the same alloy operating without magnetic field. When operated at room temperature, the alloy's figure of merit can be more than doubled through application of a 17,000 gauss field, according to BTL.

► **Laser Studied For Anti-Collision Use**—At least one avionics company is investigating possibility of designing a laser radar which could be used as an aircraft collision avoidance system. Simplicity, lightweight and small size of such a system make it appear promising, although its uses might be limited to visual flight rules (VFR) conditions.

Tests Reflect Thermal Bond Weaknesses

New York—Thermal compression bond failures of connections to semiconductor crystals have been the most widespread failure mode observed in reliability tests of mesa and planar transistors, Frank Aubin of Airborne Instruments Laboratory reported here during the Institute of Radio Engineers international convention.

"Every manufacturer's product and almost every type of mesa and planar transistor tested exhibited this failure mode," Aubin said. The units were subjected to a 60g shock of six microseconds duration along each axis, to vibration of up to 20g's to 3,000 cps, and exposed to temperatures of —55C to 85C. Early batches of mesa transistors from one "prominent manufacturer" suffered almost 100% failures from this cause, he said.

Aubin said that transistor manufacturers have since improved the quality control of their thermal bonding techniques, but such failures still occur, though less frequently than in the past. The Type 2N1132 was the only mesa transistor tested by AIL which exhibited no failures throughout the evaluation program.

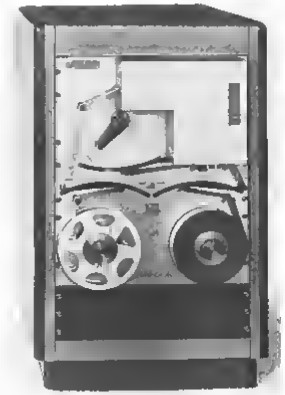
In other reports of avionics interest delivered at the IRE international convention, the following developments were reported:

• **Optical maser peak power level** of 10 megawatts for a 35 nanosecond interval has been achieved by scientists at Hughes Research Laboratories using a new technique which should permit considerably higher power levels in the future, Dr. George Birnbaum said. Using a cooled ruby crystal with one end left unsilvered and an externally located mirror with an optical shutter (Kerr cell) placed between the crystal and the mirror, the shutter is periodically pulsed to permit the inflated beam generated in the crystal to be reflected back by the external mirror. The configuration is called a "pulsed reflector ruby laser." Birnbaum said the Army Signal Corps had recently achieved similar performance using a rotating mirror instead of the Kerr cell.

• **Transistor technology** is reaching a plateau in which further gains in maximum operating frequency in the microwave region can only be achieved by a corresponding decrease in power capacity, assuming transistor impedance is not reduced, Dr. James M. Early of Bell Telephone Laboratories predicted. Basic studies indicate that the product of transistor power, maximum operating frequency and impedance is equal to a constant which is approximately equal to 3×10^{15} volts/sec. Early said. He said that the planar configuration appears to be the design of the future.

• **Novel computer** using microwave techniques, which shows promise of operating at rates above 1,000 mc., was reported by B. M. Minnes of ITT Federal Laboratories and R. T. Adams of Sichak Associates. In the technique, binary digits are represented by two UHF frequencies, 5.5 mc., which corresponds to a binary zero, and 6.5 mc., which represents a binary one. The computing rate is determined by the bandwidths of the system elements and is a function of the logic frequencies used. Data is processed in a logic element composed of simple mixers and filters. The logic element is a six input device which forms Boolean functions of two, three or four data variables, with all inputs being used in each operation. If two inputs are used for data, the remaining four are used to control the function being formed.

• **Annular slot** planar antenna array capable of generating pencil beams and which can be used for monopulse radar in both principal planes were described in a report by K. C. Kelly and F. J. Goebels, Jr. of Hughes Aircraft Co. An experimental X-band array constructed, with a 10-in. diameter weighs only 120 grams including feed structure and exhibited a gain of 20 db.



Paper-Tape Recorder

Electrostatic paper tape recorder, Model ETR-7, substitutes black spots for punched holes, using same code configuration as standard punched tape. Associated reader can handle both printed and punched tapes. Recorder prints at 400 characters per second, but higher speeds and higher-density data packing are available. Manufacturer: Omnitronics, Inc., 511 No. Broad St., Philadelphia 32, Pa.

• **Radar for unmanned** space vehicle rendezvous with a cooperative target equipped with a transponder, capable of acquiring the target at distances of 60 mi. and over a 90 deg. solid angle, was described by Howard A. Rentel of Westinghouse Air Arm Division. The chaser-vehicle radar, operating at L-band, would use four fixed plane spiral antennas and employ interferometer techniques to determine angle to the target to avoid need for moving antenna structure. System would be designed to provide accurate range information for docking at distances of less than 50 ft. between two vehicles, according to Rentel.

• **Communications satellites** may encounter more serious interference from thunderstorms and precipitation reflections of microwave energy than that from tropospheric scatter, which previously has been viewed as the principal natural source of interference, Arnett S. Dennis of Stanford Research Institute reported.

• **Brushless direct-current motor,** which utilizes the Hall Effect to eliminate motor commutator and brushes while retaining desirable high torque and linear speed-torque characteristics of d.c. motors was described by G. H. G. Bancilem of Kearfott Division of General Precision, Inc.

• **Use of chaff** for communications appears feasible, based on limited tests to date in which chaff was dispensed from a small airplane at altitudes of 10,000 to 15,000 ft. The chaff cloud fell at rates of 300 to 1,000 ft. per minute, with a horizontal drift of 40 to 100 mph., according to a report by L. H. Bauer of Radiation, Inc., and C. E. Sharp and Robert Herring of Army Signal Research & Development Laboratory. Radio signals were bounced off the chaff particles in a manner similar to that proposed in USAF's Project West Ford. Future tests are planned to try feasibility of creating chaff cloud utilizing rockets and ground-based mortars.

• **Inertia-less** steerable communication antenna operating in the high frequency (HF) band, which effectively scans up to 30 deg. off the array axis, was described in a report by Helmut Brueckmann of Army Signal Research & Development Laboratories and J. R. Gruber and C. A. Brimble of Avco Corp. An experimental ISCAN antenna installed near Washington consists of an endfire army of vertical dipoles and an electronic beam forming system. The endfire array generates 14 overlapping conical beams. By rapid switching from one beam to the next, the antenna scans over the 60 deg. azimuth coverage. The antenna array is 6,312 ft. long.

BOEING C-135B in MATS markings, powered by Pratt & Whitney TF33-P-5 engines, climbs out moments after rotation.

Aviation Week Pilot Report:

C-135B Extends MATS Range Capability

By William S. Reed

Travis AFB, Calif.—First Boeing C-135B to phase into the Military Air Transport Service inventory was delivered here last month and turned over to operations and training activities preparatory to its introduction into regular MATS Pacific schedules May 1.

Performance and handling qualities of the C-135B were assessed by this AVIATION WEEK pilot on two occasions prior to the delivery flight to Travis. First occasion was the performance of a series of tests to determine minimum control speed, V_{mc}, and the second was during the 10 landings made by Maj. Gen. Glen R. Birchard, Western Transport Air Force commander during his transition at Malmstrom AFB, Mont., and the subsequent flight to McChord AFB, Wash., and then to Travis.

V_{mc} tests were conducted on C-135B No. 61-331 by Boeing test pilot D. C. Knutson and Air Force test pilot Maj. Carl Cross. Procedure Knutson used was to start at 400 ft. altitude with the aircraft in a takeoff configuration, i.e., gear up, flaps at 30 deg., three engines at idle and either No. 1 or 4 at normal rated thrust (NRT). By gradually reducing airspeed, the point at which straight flight with not more than 5 deg. of bank could be maintained was determined. In the case of the C-135B under these conditions, the minimum control airspeed turned out to be 113 kt. with rudder boost on. A repeat of the tests with either No. 1 or 4 engines at NRT showed no difference. One rather startling fact did reveal itself. Although each test run was started at 400 ft. in smooth air over Puget Sound, the aircraft climbed to more than 1,000 ft. by the time 5 min. running time at normal rated thrust had been reached. While not a specific part of the test, the fact that the aircraft climbed on one engine, even though it was at a gross weight of only 140,000 lb., was revealing as to the performance capability of the aircraft and the power potential of the Pratt & Whitney TF33-P-5 engines. Between tests or when it became necessary to maneuver, the aircraft was flown quite handily on the two inboard engines while the outboards were allowed to cool to avoid exceeding the maximum normal rated thrust running time of 5 min.

Tests for the same performance parameter with rudder boost off proved to be a different matter. With boost on, 24 deg. of rudder throw is available but with boost off, only 9 deg. is available. V_{mc} with boost off was 165 kt., which still proves to be no problem because getting into this condition assumes a multiple failure. In addition, V_{mc} is determined under the worst possible circumstances, which are unlikely to be reproduced in actual flight. Control with three engines out and one out board operating places a more severe requirement on the rudder than does an outboard engine failure with the other three engines at NRT.

Testing for V_{mc} probably is hardest on the pilot since force gages showed that Knutson was holding about 70 lb. force on rudder pedal with boost on; about 200 lb. force with boost off.

Confirmation of the V_{mc} data was made during four tests at an altitude of 7,500 ft. to determine the effects of the sudden loss of an outboard engine while climbing at 160 kt. at normal rated thrust. This proved to be no problem and the aircraft was headed back toward Boeing Field where a maximum braking landing was performed. Using anti-skid braking to the maximum, the C-135B was brought to a stop in 2,500 ft. from the touchdown point without the use of reverse thrust. Landing weight was 138,000 lb.

The C-135B in appearance is very similar to the KC-135, of which more than 500 have been delivered to the Strategic Air Command, Eastern Transport Air Force (EASTAF) already has taken delivery on the C-135A equipped with Pratt & Whitney J57P-59W engines rated at 13,750 lb. thrust wet. The C-135B has approximately 40% more thrust, each engine being rated at 18,000 lb. thrust dry. Airframe of the three aircraft KC-135, C-135A and B, basically is the same and dimensions are identical in most respects. The lack of windows in the cabin may be disconcerting to some at first but the decision not to add windows was made in order to keep within the cost of $1.3 million per airframe less government furnished equipment (engines, instruments, electronics, etc.)

In size, the C-135 is nearest to the 720 version of the 707 but it retains the standard landing gear rather than the smaller, lighter 720 gear. The C-135 model has a large stabilizer area and greater elevator throw to offset the destabilizing effects of increased power and also uses the Series 300 (intercontinental version) vertical fin and rudder to give better engine-out control with the aircraft's higher thrust engines.

The maximum gross weight of the KC-135 is 301,600 lb., the maximum gross weight of the C-135 is 277,500 lb. Maximum gross weight of a 720B is 235,000 lb. (AW Mar. 20, 1961, p. 67). Reason for the difference in gross weights is that MATS, for reasons of structural fatigue, has decided to operate at a weight maximum which will provide a 2.5g normal load factor. SAC, on the other hand, uses a 2g load factor by reason of the fact that SAC tankers will off load their payload shortly after takeoff whereas MATS payload will be carried all the way.

Landing Weights

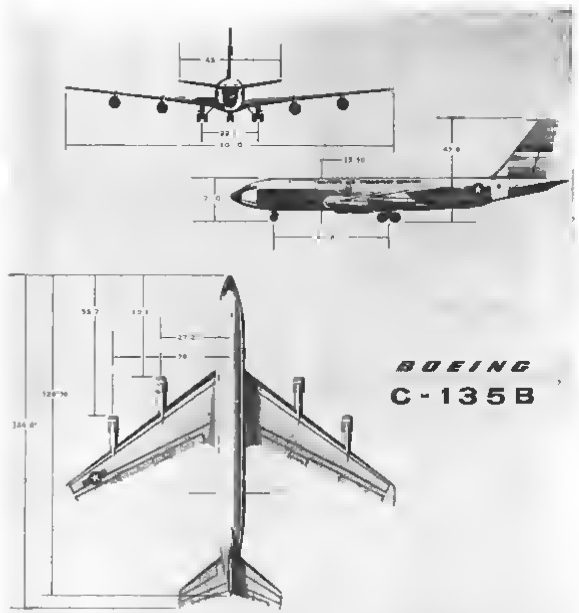
It is probable that average landing weights of MATS C-135s will be considerably greater than those of the SAC tankers. One additional factor is the presumed life of the airframes. SAC has predicated airframe utilization at a lower figure than that which MATS ultimately will attain. Then too, under war emergency conditions, tankers will be considered expendable and crews would be expected to bail out or crash land if their bomber/receiver needs all the fuel on board the tanker.

Normal empty operating weight of the C-135B is 106,470 lb. and the maximum payload that can be carried is 83,530 lb. This leaves a total of 82,000 lb. of fuel which can be carried along with maximum payload. With maximum cargo aboard, the aircraft has a range of better than 2,000 naut. mi.

Various payload/fuel combinations can be used up to a maximum fuel load of 165,000 lb. which would bring the aircraft up to maximum gross without cargo. The aircraft can hold more fuel than the operating maximum will permit, 185,766 lb. or 29,026 gal. Gross weight of up to 301,600 lb. could be flown under emergency conditions by lowering the structural margin to 2g the same as the KC-135. With no payload and with maximum permissible fuel load of 165,000 lb., the C-135B has a still air ferry range of 7,800 naut. mi. with MATS reserves. At the over load weight of 292,000 lb. still-air range probably could be stretched to 9,000 naut. mi.

Changes in the airframe between the KC-135 and the C-135B were kept to a minimum because the aircraft was purchased as an off-the-shelf item. Some changes that were necessary included:

- Addition of an extra air conditioning pack. The single pack carried in the KC-135 was not adequate for carrying up to 126 troops and a second pack was added. However, the hot air ducts run along the ceiling of the cabin and the floor becomes uncomfortably cold at altitude. Airline heater ducts are along the floor but this arrangement is not practical in the cargo carrying aircraft.
- Troop oxygen provisions consisting of a liquid oxygen converter located in the rear of the cabin.
- Seating provisions for 126 troops or alternatively, 44 litters and 54 seats for ambulatory cases. MATS figures the weight for combat equipped troops plus baggage at 300 lb. per man for a maximum of 37,800 lb. Range with full troop load is 4,500 naut. mi.
- Fuel dumping provisions which replaced the refueling boom on the KC-135.
- Cargo tiedown and handling provisions.
- Passenger facilities including soundproofing, galley and toilets.
- Cartridge starter system which makes the aircraft independent of ground power units. Only the No. 3 engine has both the low-pressure pneumatic system and the cartridge. The other three engines can be started from air bled from No. 3.



THREE-VIEW of Boeing C-135B shows pertinent dimensions. Aircraft closely resembles KC-135 tanker, used by SAC, without refueling boom and cabin windows.

Being non-competitive, MATS is not compelled to operate its aircraft outside the speed range which will yield best economy. Unlike commercial airlines which must fly at airspeeds well into the drag rise in order to meet advertising claims and schedule times, MATS will operate its C-135Bs at cruising speeds in the vicinity of Mach .80. With only slight variation, Mach .80 yields the best specific fuel consumption at altitudes in the vicinity of 35,000 ft. When necessary, the aircraft can be cruised at speeds up to Mach .88 but only at the expense of poorer specific fuel consumption. Higher cruise speeds comparable to the Boeing 720B are not practicable in the C-135B because it does not have the leading edge glove with which the commercial jets are fitted (AW Aug. 15, 1960, p. 56). The glove effectively increases wing sweep and also effectively decreases wing thickness at the root thereby decreasing drag.

Lt. Col. Floyd J. Henman, WESTAF's chief pilot and Gen. Birchard's instructor on the checkout and delivery

PROBLEMATICAL RECREATIONS 113

A town owns three snowplows which plow at a rate inversely proportional to the depth of the snow. One evening snow starts falling and continues at a constant rate throughout the night. At midnight one plow starts down the highway. At 1:00 AM a second plow starts and plows the same track as the first. At 2:00 AM the third plow follows the other two. The third plow catches up to the second at the same time that the second catches up to the first. What time did it start snowing? —*Contributed*

Cinema votaries watching the Academy Awards tonight might be interested to learn that four out of the five motion pictures nominated for excellence of sound used equipment from our Westrex Recording Systems Division. May we add that the award for sound recording excellence has been won by studios using Westrex systems 27 times in the past 31 years. (We just happened to have our credits handy.)

ANSWER TO LAST WEEK'S PROBLEM. The simplest solution is where $x = 15$, $y = 20$, $z = 12$. The general formula is: $x = m^4 - n^4$; $y = 2mn\,(m^2 + n^2)$; $z = 2mn\,(m^2 - n^2)$.

flight, set up the same cruising conditions on the delivery flight that will be used on actual route flying. At 34,000 ft, performance curves showed that Mach .80 would yield the most nautical air miles per pound of fuel (NAMPPF). Airspeed for Mach .80 is 277 kt. IAS which is 460 kt. or 530 mph. TAS. Stabilizing on a precise airspeed proved to be difficult because small changes in power produced large airspeed changes. Some time was spent by both Henman and this AVIATION WEEK pilot in trying to find the power setting which would give 277 kt. IAS and the result was that the airspeed was chased from 275 to 280 kt. Holding the airspeed precisely at 277 was not too important because frequent reductions in power would be required to maintain 277 kt. as the gross weight decreased from fuel consumption. Holding the airspeed between 275-280 kt. proved to be an effective way of flying at an average speed of 277.

First WESTAF squadron to be jet equipped will be the 44th Air Transport Squadron at Travis and crew flying training began immediately after the aircraft arrived. Total complement of aircraft is scheduled eventually for 16, for which a total of 36 crews will be trained under the MATS standard of 2.25 crews per plane. Rate of delivery of new C-135Bs to Travis will vary between one and two per month. Scheduled introduction on WESTAF routes is May 1. First route will be Travis to Hickam AFB, Hawaii, to Yokota AFB, Japan, and return. As more aircraft become available, plans call for the jets to be used on the Travis, Elmendorf AFB, Alaska-Yokota and return run and also on direct flights, where the load warrants, from Japan to the U.S. Initial utilization figure is 5 hr./day.

MATS Routes

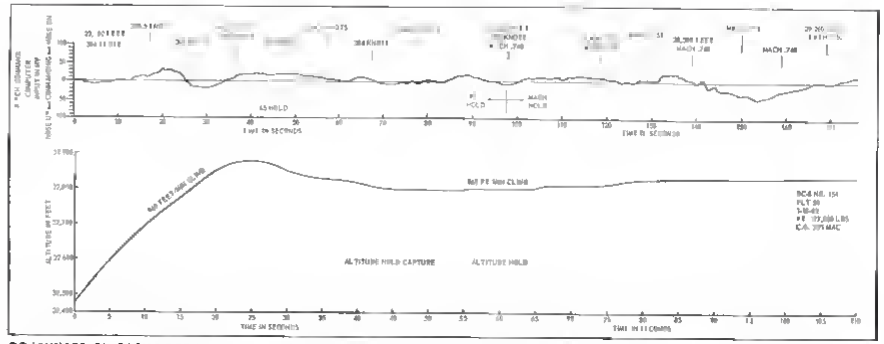
Initially, routes, cargo and flying times will be:

- **Travis to Hickam**—35,000 lb., 5.25 hr.
- **Hickam to Yokota**—35,000 lb., 8.45 hr.
- **Yokota to Hickam**—52,000 lb., 6.55 hr.
- **Hickam to Travis**—52,000 lb., 4.40 hr.

Second route to be scheduled for the C-135B will be:

- **Travis to Elmendorf**, 4.25 hr. Elmendorf to Yokota, 7.25 hr. with 42,000 lb. cargo.
- **Yokota to Elmendorf**, 6.45 hr., Elmendorf to Travis, 4.10 hr., with 46,000 lb. cargo.

The scheduled payloads do not represent the maximum capacity of the aircraft over the routes designated. If ideal cargoes of the proper density could be loaded for every flight, payload could be considerably higher.



DRAWINGS OF OSCILLOGRAPH traces made during flight test show accuracy with which values are maintained. Top trace shows variation of 2 kt. during climb through 2,000 ft. Mach Hold was switched on at 98 sec., maximum Mach variation was 0.005

Sperry Autopilot Shows Control Capability

Long Beach, Calif.—Automatic landing approaches to altitudes as low as 50 ft. have been demonstrated by a Sperry autopilot-equipped Douglas DC-8 to 43 pilots and engineers representing foreign and domestic airlines.

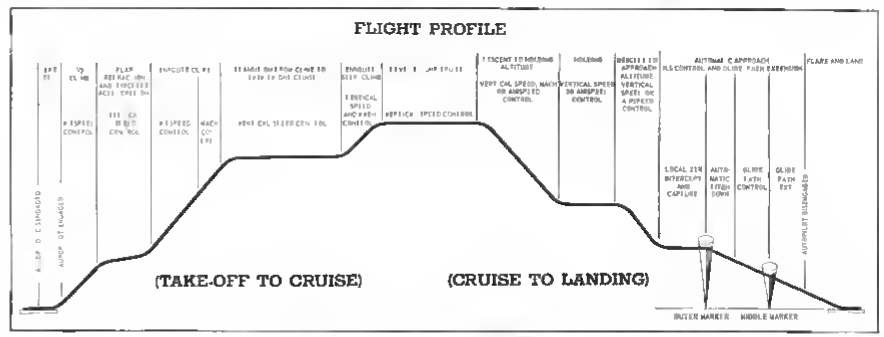
The flight demonstrations were the culmination of the combined efforts of Douglas Aircraft Co. and Sperry Phoenix Co. aimed at providing a flight control system which will permit jet transport operators to fly to lower landing minimums (AW Dec. 11, p. 85).

The advanced Sperry SP-30 autopilot system also will permit more economical cruise through automatic airspeed and/or Mach number control and will provide precise speed and altitude control while entering or leaving air traffic control areas.

Installation of the SP-30 requires only minor changes to the aircraft wiring system which means minimum downtime for operators. Control head for the autopilot is located on the center pedestal aft of the throttles. Pilot controls consist of:

- **Pitch selector rotating switch** with five positions—Mach Hold, IAS Hold, Vertical Speed, Glide Path Extension, and Pitch Hold.
- **Vertical speed selector wheel.** When pitch selector is on Vert. Speed position, altitude hold will maintain selected altitude when wheel is in that position. Constant vertical speeds are maintained with the selector. Vertical speed wheel roughly follows the rate of climb so aircraft will maintain a selected rate of climb if pitch selector is moved from Mach or IAS hold. Also pitch selector automatically returns to the Vert. Speed position if the vertical speed wheel is moved by the pilot.
- **Turn Knob.** Identical to other autopilots and is used to make coordinated turns.
- **Three position switch** which turns autopilot on and off. Mid-position is for operation of yaw damper without autopilot operation.
- **Navigation selector.** A five-position switch, the Nav. Selector normally is in the Turn Knob position. Other positions are used to automatically track on the Doppler navigator a preselected heading, localizer or VOR beacon, or for automatic ILS operation.

A preview of the demonstration made to airline personnel was given an AVIATION WEEK pilot on a flight during final checkout of the equipment. A. G. Heimendinger, Douglas chief test pilot, put the number 154 DC-8, N 9607Z, through a complete series of autopilot maneuvers for the benefit of several Sperry and Douglas engineers to assure that all bugs were worked out of the equipment, some of which is in test status. Components in the Mach and indicated airspeed (IAS) function of the SP-30 have not yet been brought



FLIGHT PROFILE shows how Sperry advanced SP-30 autopilot is used for all of flight except few seconds after takeoff and before landing.

up to production standards and some minor problems needed to be worked out.

Control of the aircraft was completely by autopilot throughout the flight from the moment the airspeed reached 160 kt. until cutoff at about 50 ft. on landing approach. Three approaches were made to Long Beach airport and landing could easily have been made out of any of the three.

Climb-out Control

The SP-30 was switched after takeoff to the IAS Hold mode as the airspeed reached 160 kt. A noise abatement departure was made which called for climb to 1,500 ft. at 160 kt. at which altitude power was reduced to maintain constant altitude until over an unpopulated area. The autopilot maintained 160 kt. at maximum continuous power with 25 deg. of flaps extended and transitioned the aircraft smoothly into level flight as power was reduced.

During climb it was noted that the vertical speed wheel which allows the pilot to select a constant rate of ascent or descent, was reading approximately in accordance with the rate of climb needle. Once at 1,500 ft., it was only necessary to position the vertical speed wheel to the Alt. Hold position and the selected altitude was maintained. Manually positioning the vertical speed wheel causes the pitch selector switch to flip automatically into the Vert. Speed position where it will remain unless switched to one of the other four functions.

Power was applied after clearing the noise abatement area and flaps were retracted while the autopilot held the DC-8 at 1,500 ft. Once a maneuvering speed of 260 kt. was reached the pitch selector was moved to IAS Hold and climb commenced. To illustrate how airspeed can be changed, the vertical speed wheel was moved to decrease the rate of climb once the control area was cleared and airspeed built up to 310 kt., best climb speed. When 310 kt. showed on the airspeed, the pitch selector was again returned to IAS Hold because it automatically reverted to Vert. Speed position when the vertical speed wheel was moved. (This allows corrections or changes without disengaging the autopilot.)

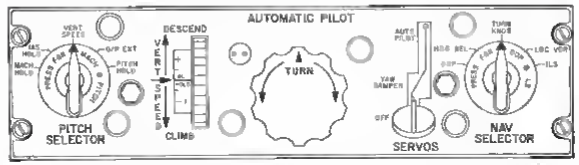
Although description of the operation thus far may sound rather complex, in practice it is simple and relieves the pilot of considerable strain insofar as holding airspeed and altitude while at the same time tending to radio and navigation problems encountered in an instrument departure. The only functions performed by the pilot to this point since engaging the autopilot were to change power settings and manipulate two switches on the autopilot console.

The SP-30 held the airspeed at a constant 310 kt. throughout the climb while rate of climb was varied by power adjustments. At approximately 28,000 ft., the climb scheduled calls for changing to a constant Mach number of 0.78. This was done by switching to Mach Hold as 310 kt. corresponded to Mach 0.78. The selector switch had to be depressed to go into the Mach Hold position, thus preventing inadvertent selection of this function when switching to IAS Hold.

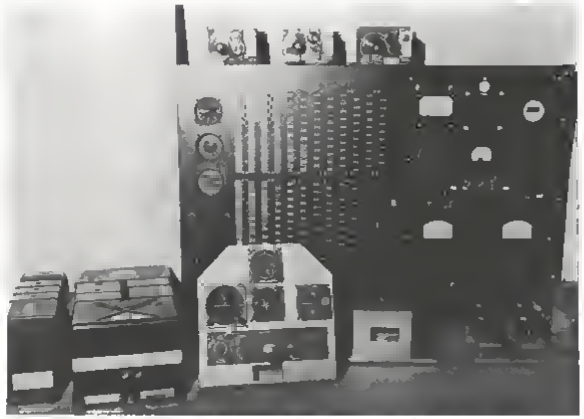
Level Flight

Level flight was assumed by moving the vertical speed wheel to Alt. Hold as the desired altitude approached. The system captured the altitude and leveled the craft precisely without having to bracket the chosen altitude. Once cruise speed was attained, power was reduced to maintain the desired speed.

The demonstration thus far proved that the system functioned as advertised. Douglas and Sperry contend that aside from relieving the pilot of many tasks, the IAS and Mach Hold features get the aircraft to altitude quicker and with less fuel consumed because jet climb performance can be seriously compromised if the prescribed climb schedule is not maintained. Leveling off at a prescribed altitude also is important to fuel consumption because overshoots and bracketing the altitude can delay reaching cruise speed. During cruise the autopilot can be beneficial to fuel conservation because cruise conditions change rapidly as fuel is consumed. The best cruise is one during which altitude is increased gradually



DRAWING OF THE SPERRY advanced SP-30 autopilot shows the control head which is located on the center pedestal aft of throttles. Pitch selector, which is the function most used, is located close to the pilot's right. Vertical speed wheel roughly follows the aircraft's rate of climb indicator so that autopilot maintains a constant rate of ascent or descent if IAS Hold or Mach Hold is turned off.



AIRBORNE COMPONENTS of the Sperry advanced SP-30 autopilot are shown above on a test bench. Left to right are stabilization computer, flight control computer, cockpit instruments and control head, and gyro. Panel in rear can duplicate all flight conditions for demonstration and system checkout.

as gross weight decreases. This cruise-climb allows the aircraft to cruise at a more or less constant relationship between gross weight and pressure altitude known as W/δ. This can be closely approximated by cruising at a constant Mach number and letting the aircraft climb at 20-50 ft./min. If this is not possible because of traffic control, step climb is the next best procedure or a constant Mach cruise at a constant altitude. The latter requires that power be reduced as airspeed increases with the consumption of fuel. Regardless of which cruise control method is used considerable fuel savings can result. While these various techniques are difficult for a pilot to fly with the required precision—almost constant attention is required in flying cruise control accurately—the techniques are within the capability of the SP-30. Depending on traffic control, the constant altitude or constant Mach cruise can be flown by the autopilot and with greater precision and care than most pilots could devote to the task.

A demonstration of descent procedures also showed the value of the SP-30. Maximum speed is either Mach .88 or 350 kt., whichever is less. Should an emergency descent be necessary, full reverse thrust is employed in the inboard engines resulting in a floor angle of about 30 deg. Use of the autopilot in the Mach Hold or IAS Hold modes during descent will prevent inadvertent exceeding of the maximum speeds which easily could be done especially in the confusion which might result during the loss of cabin pressure.

After descent, the value of IAS Hold and Alt. Hold again was demonstrated while maneuvering in the control zone. Greater pilot attention was focused on traffic conditions and radio procedures than would have been possible flying the aircraft manually. During holding or in making step-descents the autopilot removed most of the burden from the pilot especially when it became necessary to change configuration of the aircraft while changing airspeed and/or altitude simultaneously. Use of either IAS Hold or Alt. Hold functions permitted accurate speed or altitude control during the control zone maneuvering.

Entry onto the ILS localizer beam is accomplished automatically by heading the aircraft toward the beam at any angle of 90 deg. or less to the beam heading or by having the system track automatically to the ILS outer marker. Capture of the localizer is initiated when the Nav. Selector is turned to ILS. At this time the ILS "Off" light will illuminate showing that a signal is being received but the beam has not yet been reached. All three approaches made during the flight made by AVIATION WEEK saw the SP-30 capture the localizer beam with a minimum of bracketing, although in each case the beam was approached at 90 deg. Even though no difficulty was experienced with the operation of the system, the amount of bank authority used by the system was somewhat disconcerting. In one case, slightly more than 30 deg. bank angle was put in by the autopilot when turning onto the localizer. This made for a brisk entry into the ILS which seemed rather severe at an altitude of 1,500 ft., flying at 160 kt. with flaps down. Limiting the angle of bank to 20 or 25 deg. at the most would cause less anxiety although the maneuver would have to be started sooner and at less signal strength.

Once on the localizer, the aircraft will continue inbound while maintaining altitude until the glide path beam is intercepted. The ILS "Off" light will go out when the glide path is reached and the aircraft will program into a nominal rate of descent for 10 sec. after which the autopilot will seek out the glide path. The pilot need only maintain the required airspeed by controlling the power.

At the middle marker or at some predetermined altitude as indicated by the pilot on a radio altimeter, the ILS "Off" light will illuminate again indicating that the autopilot is disregarding the glide path signal and is following a memorized glide path dictated by the average rate of descent experienced from the outer marker.

This procedure is used to avoid following glide path indications close to the runway because of the extraneous "noise" which generally plagues ILS systems at this point. Type of system installed in N 9607Z is triggered by the middle marker but the memory system can be invoked sooner at pilot's discretion by switching the pitch selector to the C/P Ext. (glide path extension) mode.

PRODUCTION BRIEFING

Sperry Utah Co. of Salt Lake City, a division of Sperry Rand Corp., has received a $12.7-million Army contract for continued production of Sergeant guided artillery missiles.

Lockheed Georgia Co.'s new plant at Clarksburg, W. Va., has begun production of subassemblies for C-130 Hercules transports with initial delivery to the main assembly plant at Marietta, Ga. The Clarksburg facility's present personnel strength of 66 is expected to increase eventually to about 200.

Artite Division of the Electrida Corp., Culver City, Calif., will produce titanium pressure vessels for Project Mercury and other missiles and space vehicles under new orders totalling approximately $1.2 million from General Dynamics/Convair, Bell Helicopter Corp., North American's Rocketdyne Division and Lockheed Missile and Space Co.

Radio Corp. of America has received a $1.6-million Army contract for development of Multi-system Test Equipment, capable of providing field support for Mauler and future missile systems and limited support for existing Army missiles.

So far we've only scratched the surface at Northrop Ventura

Construction is getting under way on the new home of Northrop's Ventura Division (formerly Radioplane). Located in Ventura County 50 miles northwest of Los Angeles, it will be ready for occupancy in December, 1962.

We've only begun to explore the capabilities of Northrop Ventura, too. *But what a beginning it is!*

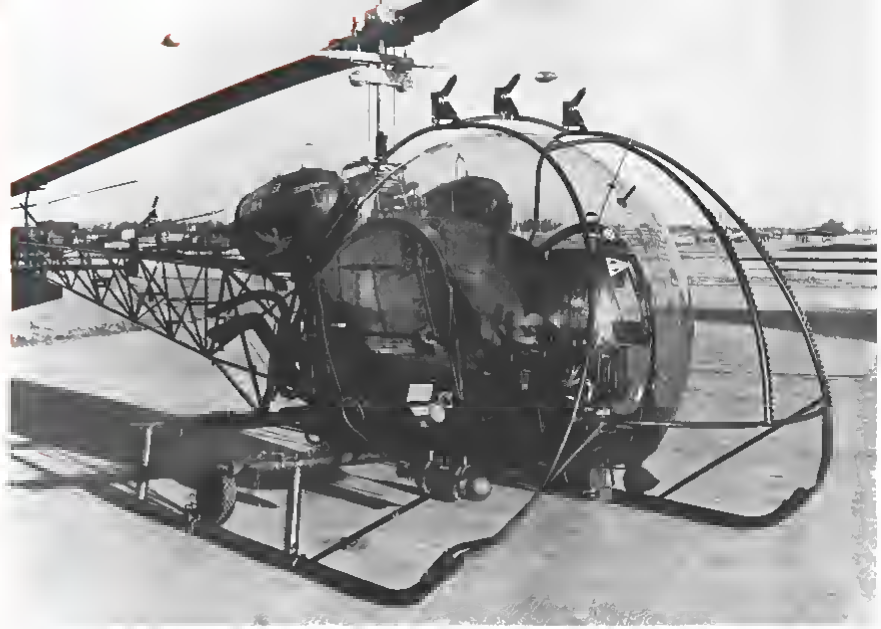
Item. Northrop Ventura is making recovery systems for every manned space capsule now scheduled by the U.S., including the landing systems which have brought the Mercury astronauts safely back to earth.

Item: Northrop Ventura is now providing crew escape systems for America's high performance manned aircraft.

Item: Northrop Ventura target drones and missiles, surveillance drones and support systems are now in use by all three U S armed services and 14 foreign countries.

The new name and new facilities reflect Northrop Ventura's increasing capability in fields where its leadership is already well known... paradynamics, atmospheric re-entry and planetary landing systems, and surveillance systems. In addition the division will broaden its capability in nucleonics, invulnerability of weapons to nuclear effects, penetration aids for ballistic missiles, and other advanced fields

NORTHROP



CABLE DEFLECTORS, with cutters mounted above the cockpit bubble canopy, have been devised on an experimental basis to improve H-13K's "nap-of-the-earth" capability in areas where phone or transmission lines are common.

Bell Demonstrates H-13K Tactical Uses

By Erwin J. Bulban

Ft. Worth, Tex.—Tactical value of highly-maneuverable H-13K Sioux light helicopter that permits "nap-of-the-earth" operations even over rugged terrain while maintaining necessary flight safety margins has been demonstrated to high-ranking U. S. Army officials here and in Europe by Bell Helicopter Co. Assistant Vice President Joseph Mashman.

Demonstrations were carried out with a standard Bell 47G-3B carrying Army markings to point up how the new model's turbo-supercharged Lycoming 260-hp. TVO-435 engine, improved control system with added boost and larger main rotor and longer tail boom make possible a whole new regime of maneuvers and tactical applications.

The H-13K closely meets field needs for equipment that can utilize the utmost in natural obstacle concealment to carry out sky cavalry functions of reconnaissance and strike with minimum exposure to enemy reaction.

An additional payoff as a result of demonstrating the H-13K's capabilities was a sharper awareness on the part of staff officers of the tactical possibilities of such operations. The manufacturer also was awakened to the potentials, including development of additional equipment to increase these capabilities. As Bell officials noted military specifications primarily center on performance and do not reflect maneuverability, terrain avoidance and other factors necessary for full utilization of the machine.

Initial demonstration of the H-13K was given Army Aviation Director Brig. Gen. Delk M. Oden here at the company's facilities and Gen. Oden appeared sufficiently impressed by the machine's capabilities that Bell Helicopter arranged for a tour to the Continental Army Command at Ft. Monroe, the Pentagon, Ft. Meade, Ft. Rucker and Ft. Bragg. Flown during these trips were numerous staff officers including Gen. Hamilton Howze, Strategic Army commander, Maj. Gen. Thomas Van Natta, combat development, Continental Army Command, and Undersecretary of the Army for Installations and Logistics Paul R. Ignatius.

The European trip covered numerous installations and included demonstrations with Gen. Bruce Clark, commanding general of the U. S. Army-Europe, and Gen. Andrew J. Goodpaster, commander Army 8th Division Europe.

Maneuvers included presentation of

Bell H-13K Sioux

Gross weight	2 850 lb
Empty weight	1,713 lb
Service ceiling	20,000 ft
Hovering ceiling, out of ground effect, standard day	15 600 ft
Maximum speed	91 kt
Maximum rate of climb at sea level	980 fpm
Fuselage length	31 ft. 7 in.
Height	9 ft. 3 6 in.
Width	7 ft. 6 in.
Main rotor diameter	37 125 ft
Tail rotor diameter	5.84 ft

the so called "Army Dozen," a series of twisting weaving and dodging flight configurations developed informally, in some cases borrowed or improved upon from tactics used by agricultural helicopter operators aimed at using trees hills, river beds as concealment and to confuse the enemy

Performance Restrictions

Because of performance restrictions imposed by safety requirements, many of the "Army Dozen" maneuvers are considered illegal However, indications are that the Army is planning to develop skills necessary for handling them by providing a special course at its pilot helicopter training school, Camp Wolters, Mineral Wells, Tex, this summer utilizing older H-13Ks for the indoctrination

The requirements for violent handling of the equipment to perform these maneuvers fall well within the H-13K's demonstrated capabilities because of its quick reaction, and Bell hopes that its demonstration tour will develop into orders for the aircraft Summarizing some of the maneuvers performed by the H-13K are these descriptions of the "Army Dozen":

- **Twists,** which are evasive skids at cruise speeds, spraying machine gun fire to develop enemy locations
- **Hit the deck,** a rapid descent to avoid getting hit or sustaining additional damage
- **Low autorotation** comprised of low-level autorotations from three to 15 ft altitudes
- **Jump-fire-run,** in which the helicopter executes a sharp vertical climb from a concealed position, stops abruptly at or slightly below tree top level, fires a machine gun burst at the enemy and then peels off sharply for a getaway
- **Reversal,** which involves making 180-deg sharp turns in confined area using maximum sideward stick displacement at cruise speed
- **Cornering autorotation,** which involves making autorotations from downwind or crosswind cruise, turning 90-deg into the wind while at three to 15 ft altitudes
- **Pinnacle stop,** a low level, high speed approach to a pinnacle or hill and landing directly without gaining altitude above the pinnacle
- **Scramble,** which involves a rapid low-level takeoff regardless of wind condition, for downwind takeoffs and emergencies
- **Quick squat,** a low-level downwind landing with 180-deg turn into the wind just prior to touchdown
- **Blivet,** a low level approach and landing in a confined area which may be smaller than the rotor diameter This maneuver may involve flying through underbrush
- **Whoa boy,** a low-level quick stop using sideward flare to reduce exposure to the enemy
- **See-saw,** a series of snap vertical climbs and rapid descents for use in artillery fire spotting

In addition, the H-13K demonstrated the "tactical corner" a 90 deg sharp turn, which involves loads of 2g and a 60 deg bank to obtain turn radius of 50 75 ft, which is useful in weaving around trees

SHARP TURN, pulling up to 2g, is demonstrated by Bell Helicopter Co Assistant Vice President Joseph Mashman in H 13K in going around large tree after flying at low level between trees Among modifications Bell has developed to enhance aircraft's abilities in heavy brush is incorporation of a four pound steel blade knife that would be fitted to the rotor blade tips to improve ability to fly directly into brush and between closely spaced trees

HOLES, simulating enemy fire effects, were made in main and tail rotor blades of H 13K and ship was demonstrated without ill effects from damage (left) Bullet proof Plexiglas panels (right) capable of withstanding 30-cal fire, are shown fitted experimentally to H-13K Crew could also wear flak suits and vital underportions of cabin would have flak curtains.

Additional Boost

Mashman emphasized that the H-13K's additional boost in the control system making possible rapid rate maneuvering, its longer main rotor—two feet longer than that on the H-13H—and its 14-in longer tail boom all permit the trained pilot to violently work the collective and pedal controls with minimum tiring of muscles

This is due to the lighter forces he is required to impose and yet have the flying characteristics enabling these rapid changes with a high degree of overall safety

Use of the turbo-supercharged engine makes possible full utilization of the helicopter's capabilities day in day-out with minimum restrictions due to temperatures and altitude conditions To point up these capabilities he noted how during a typical hot summer day here in the Ft Worth area the H-13H's conventional engine, delivering 240 takeoff horsepower can fall off to 188 hp at 7 500 ft and to only 125 hp at 15,000 ft, while the TVO 435 maintains the 260 hp rating right up through 15,000 ft

Modifications Considered

With this capability of violent maneuvering available Bell has considered numerous modifications to enhance missions utilizing these techniques Among these are a four pound steel blade knife that would be fitted to the rotor blade tips to improve the aircraft's ability to fly directly into brush and between closely spaced trees—without these blades Mashman has lopped branches of approximately one inch thickness—bullet proof Plexiglas capable of resisting 30-cal gun fire, flak curtains and wire deflector-cutter gear Deflectors could be equipped with explosively actuated cutters capable of severing ¾-in steel cable, Bell states

Among the applications of the aircraft would be the use of the H 13K in drone form as flankers or lead ships, fitted with the cable cutters and machine guns to clear the path for a follow-on patrol or for troop-carrier helicopters

Drone system already has been developed for a pair of H-13Es for a special Navy weapons test program and its capabilities include range control of over 15 mi

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Life Support Algae Studies—General Electric, MSVD

Mergenthaler Aims at More Military Sales

By Arnold Sherman

New York—Mergenthaler Linotype Co is acquiring controlling interest in the Electric Autolite Co, which in turn controls Hiller Aircraft Corp as a wholly owned subsidiary (AW Nov 28, 1960, p 37). Mergenthaler officials view the acquisition as a substantial move toward more defense oriented activity.

Mergenthaler, with headquarters at Brooklyn, N Y., has been a major producer of linotype and other printing equipment since 1895. Although the major portion of the company's business is still predicated on supplying printing equipment, the firm has been steadily building an aerospace capability. The company produced the post-Korean war, Saab-developed but later electronically modified M-1 and M-2 toss bomb computers, the latter of which is being utilized by the Air Force in the Lockheed F-104.

In spite of Mergenthaler's efforts—which include a high-priority research and development program—the company's share of the aerospace dollar has dwindled markedly since 1957. In that year, with a net sales total of $54.3 million, military business accounted for $13.5 million. In 1961, however, with net sales of $54.5 million, military business had fallen off to $3.8 million.

Mergenthaler, in the acquisition, is thus buying control of a company whose $161 million 1961 net sales volume was roughly three times that of Mergenthaler's.

Prime mover in Mergenthaler's diversification drive is Gordon W. Wattles. In addition to being chairman of Mergenthaler's board of directors, Wattles is president of American Manufacturing Co., Inc., which owns 31.67% of Mergenthaler's outstanding stock. Coincidentally, Wattles has been a member of Autolite's board of directors since 1957 and for a time served as its chairman. It was in 1957, in fact, that Mergenthaler began acquiring appreciable interests in Autolite.

At the time of the exchange offer to Autolite shareholders on Mar. 7, Mergenthaler already had acquired 408,950 shares of Autolite stock—or roughly 34% of all the stock outstanding.

The offer to Autolite shareholders consisted of a proposal to exchange not in excess of 300,000 shares and not less than 188,000 Autolite shares at the rate of one Mergenthaler share and $32.00 principal amount of Mergenthaler subordinated debentures for each Autolite share tendered. The 188,000-share minimum was calculated to be enough to give Mergenthaler majority control of the company. As it developed, over 200,000 shares were exchanged. At the time of the offering Mergenthaler stock was selling at about 31, while Autolite common fluctuated between 63¼ and 63.

Mergenthaler's cash assets are reported at about $4.5 million. Since the exchange represents an exchange of securities and the offering of debentures, there will be no drain on Mergenthaler's assets.

An appreciable part of Mergenthaler business has been in export and through its foreign subsidiaries—principally in England and West Germany. Foreign sales account for more than half of total business.

One factor that may have substantially improved Mergenthaler's bargaining appeal in terms of the Autolite stockholders was the major decline Autolite experienced in the Fiscal 1961 period.

Autolite was incorporated in Ohio in 1922. It later acquired for cash and assets the Electric Auto-Lite Division of Willys Corp. On Nov. 30, 1960 it purchased Hiller Aircraft Corp., Menlo Park, Calif., for 134,729 shares of common stock. In that same year it acquired the Equitable Leasing Corp. (renamed Equilease Corp.) which was engaged in leasing of business and industrial equipment.

Equilease jointly owns Nelco Corp. with Aviation Financial Services. Nelco was formed specifically to lease six Convair 880s to Northeast Airlines (AW Apr. 10, 1961, p. 41). General Dynamics felt it needed cash rather than income and wanted the lease, though it had to be backed by General Dynamics credit. General Dynamics is guarantor of $18-642,000 in rental payments due under this agreement.

Autolite primarily manufactures automotive electrical equipment and parts. The company also produces aircraft instruments, gages and batteries, and—through Hiller—helicopters.

The company experienced a sharp reversal in its fortunes when in 1957 the Chrysler Corp. notified Autolite of its intention to manufacture a number of principal items of electrical equipment which Autolite hitherto had supplied. The manufacturing was to become effective at the end of a three year period, and it embraced a total of 14% of Autolite's over-all sales.

Adding to Autolite's dilemma, Ford Motor Co. announced that it planned

Marine HSS-2 to Be Assigned to Kennedy

Twin turbine Sikorsky HSS-2 helicopter will be flown by U. S. Marine Corps in the Executive Flight Detachment and will be used this summer to transport President Kennedy and high government officials, replacing single-piston-engine Sikorsky S-58s which have been used for Executive flights since 1957. Four Marine Corps HSS-2s and four Army versions will be assigned to the detachment. Eighteen Marine pilots and 17 Army pilots and support crews have been trained for this duty at Marine Corps Air Station, Quantico, Va.

to produce its own batteries and spark plugs. Making the best of the situation, Autolite sold Ford its spark plug plant at Fostoria, Ohio and a battery plant at Owosso, Mich. for $28 million on Apr. 12, 1961. Included in the transaction was the trade name "Autolite."

Thus, in spite of the fact that Hiller received an Army contract in 1961 in excess of $6.5 million for the H-23D, that it was one of the LOH finalists and one of the firms chosen in the tri-service VTOL competition, and that Equilease's renting services have been steadily expanded, 1961 portended a drastic reduction in Autolite's traditional sales activity.

Sales Record

In 1961, Autolite's net sales were $161,795,131. A year earlier they were $221,819,216. In 1959 they amounted to $220,772,395, and in 1952—10 years earlier—they accounted for over $271 million. Earnings before taxes similarly were affected. In 1961 the company earned $6.7 million, in 1960 $12.8 million, in 1959 $15.6 million, in 1952 $22.3 million.

President of Mergenthaler, J. A. Keller, said that "despite the setbacks Autolite has experienced, Autolite has a proven capability to earn money. The potential is there and you can't blame a company for reversals that are not of its own making."

Autolite President R. H. Davies for his part, faced with the Mergenthaler exchange offer, told shareholders that ". . . the management of Electric Autolite considers that in view of Mergenthaler's large interest, equivalent to approximately 34% of Electric Autolite's outstanding stock, and the relationship that has existed for several years with that company, it is appropriate for Mergenthaler to offer to acquire additional shares so as to make it a majority shareholder."

Keller does not foresee any change in Autolite's present management structure as a result of the acquisition. "There are no plans for a shakeup at Autolite," he emphasized. "Over the years in which Mergenthaler has had an appreciable interest in the company, we have been satisfied that Autolite has been well run."

Some vagueness exists about what, if any, additional liaison will be required between the companies but the probabilities are that the only additional change contemplated in the future might be introducing more Mergenthaler directors onto the Autolite board. Keller, Wattles and Malcolm E. McAlpin of Mergenthaler currently serve on Autolite's board.

"There are no changes contemplated in Autolite's business policies," Keller said in an apparent answer to customer rumbles that Mergenthaler might try to reorient Autolite's sales and production policies.

A Mergenthaler stockholder suit, initiated in March, 1959, alleging that the Mergenthaler purchase of Autolite stock was not for a proper corporate purpose is still pending. Mergenthaler contends the action is without merit.

While Mergenthaler's military business has been less than spectacular, its printing supply functions have continued to grow. Net printing sales for Fiscal 1958 were $37.9 million, 1959, $38.7 million, 1960, $46 million, 1961, $50.7 million.

Current Mergenthaler defense-oriented business cited by Keller includes the following programs:

- **U. S. Navy Hydrographic Laboratory** contract to measure stress on ice.
- **North American Aviation's** Autonetics Division subcontract for bombing computers.
- **Rome Air Development Center** feasibility study for development of printout devices for graphical and lexical utilization of computer output. The system would incorporate high-quality printing tied in with computer outputs at the rate of 600 characters per second.
- **Navigation and fire control** instrumentation for helicopters. Keller cites this as an example of how Mergenthaler's electronic outgrowth from modern printing developments can be made to dovetail with Autolite's subsidiary activities. "We feel there is a real future for helicopter instrumentation," Keller said, "and we intend to explore those avenues with Hiller."

Defense Sales Future

Keller estimates that on the basis of figures in and proposals out, Mergenthaler will increase its defense business this year to $7 million. "The acquisition of majority control of Autolite is not the end of the road for us by a long shot," he said. "We will continue to search for businesses compatible with our own outlook in order to diversify in areas where we have proven capabilities."

Mergenthaler underwent some basic management changes in 1948. The company felt that new management policies were required and as a result the management firm of George Fry & Associates was called in. Keller at that time was a vice president of Fry and it was then that the future Mergenthaler president became acquainted with the company. Keller joined Mergenthaler in December, 1955, as vice president-operations. In 1958 he was promoted to executive vice president and in that same year, at the age of 41, succeeded Martin Reed as president. "Since that time the ages of the officers of the company have been in the low forties," according to one of the company's officials.

Keller is an advocate of operating through a small management group instead of the conventional committee and staff meeting each time a new policy decision is required.

As a result of this tightening up and consolidation of functions, administrative expenses have been correspondingly reduced, he said.

RAF Vulcan Tested With Dummy Skybolts

First photo of Avro Vulcan B2 V-bomber of Royal Air Force carrying dummy Douglas Skybolt missiles shaped in earlier configuration. Black bulges on lower wingtips and belly are part of Skybolt control system. RAF has made at least one free-fall test of Skybolt in the United Kingdom, over the North Sea.

Labor Party Calls UK Aviation "Bumbling"

By Herbert J. Coleman

London—British Labor Party has sharply criticized government handling of the British aviation industry as "bumbling and inefficient" and called for more efficient planning to eliminate uncertainty which now prevails.

In a House of Commons debate, the "shadow minister of aviation" Frederick Lee, charged the government—and, in particular, Minister of Aviation Peter Thorneycroft—with failure in these areas:

- **Lack** of efficient planning between government and industry, with more adequate interchange of information.
- **Need for greater efficiency** in estimating costs, and an end to a government tendency to exaggerate production targets.
- **Laxity** in not ordering the Hawker P.1127 vertical takeoff strike fighter into production, when Britain holds a lead in this field, and delay in pressing the Short SC.1 VTOL program.
- **Failure** to concentrate on a short haul civil jet transport. Lee also accused Thorneycroft of "dithering around" on the joint Anglo-French supersonic transport project (AW Apr. 2, p. 26).
- **Lack of correct balance** in the industry between production and research and development, coupled with the need to develop incentive contracts to replace fixed price and cost-plus contracts (AW Mar. 12, p. 278).
- **Promoting excessive** competition between types of projects and a lack of harmonization between service and civil programs. Lee reminded the House that the "greatest success story in civil aviation, the Boeing 707, began as a tanker."

In rebuttal, Thorneycroft reiterated his policy that in exchange for an industry pledge to form into major groups, government orders would be concentrated in the groups. He stressed that the industry faces concentration of its facilities but he would back the publicly owned research facilities.

Thorneycroft also forced Lee to admit that he favored nationalization of the industry, and countered: "At least we know now that the party opposite wants to nationalize the industry and that all this baloney about planning and the rest of it, all these polite phrases, are merely a smoke-screen."

The minister said government policy for the aviation industry will remain merging of groups, backed by research and funds provided by the government. He said government expenditure now is $900 million in defense aspects of aviation, with about $30 million put into support of the civil side. Industry now employs about 300,000 persons, and is Britain's second largest. In the past 18 months, employment has risen about 20,000.

Thorneycroft referred to new British aircraft flying and in development—the P.1127 and TSR.2 fighters, de Havilland Trident, Vickers VC.10 and BAC 111, Short Belfast and Skyvan and the Beagle line of private aircraft—as a "picture of activity." Exports have reached $500 million, supported by another $125 million from the electronics industry.

Major problem confronting the industry, Thorneycroft continued, is the future of the design staffs, adding that the government cannot make premature decisions simply for the purpose of occupying the times of these teams.

"The problem is really two-fold," he declared. "One is the technical aspect of starting a project, which begins with the design team. The other is how to stop it if it is not suited to the needs, or it is not quite up to the needs that have been developed."

Supersonic Aircraft

Thorneycroft also assured the house that there will be a supersonic aircraft and said he will be meeting with M. Buron, the French minister of transport, to analyze the project in the area of costs and administration for presentation to the two governments.

The minister backed work of the Royal Aircraft Establishments in the fields of blind landing, turbine engines and microminiaturization, but admitted the ministry has come up with troubles in missiles and weapon systems. Government has been criticized for not having signed a contract for a British army order for the Vickers Vigilant anti-tank missile, but the explanation is that the missile's fuze is not yet satisfactory.

As far as support for the P.1127 with its Bristol Siddeley BS.53 deflected thrust engine, and the Short SC.1 with the Rolls-Royce pure lift engine, Thorneycroft said:

"It would be very nice to place massive orders for all these things, but we have to work within the limits of what we can do. We work much better when we work with other countries. . . . The Americans and Germans in the P.1127 and the Germans and French with the Rolls-Royce engine [RB.162]."

In renewed opposition attacks, Labor members brought up these points:

- **Only 24 orders** for the Trident have been placed (by British European Airways) and breakeven point will be 120 sales.
- **Exports of military** and civil aircraft have nosedived, in Lee's opinion, from 173 combat and 77 civil planes in 1959 to 21 combat and 40 civil in 1960. This military slump is due, he said, to the almost complete domination of the European market by the Lockheed F-104 program.
- **Cancellation** of the Westland Rotodyne (AW Mar. 5, p. 26) is an example of "lack of decision leading to uncertainty." Lee claimed that Westland, as late as two months ago, was proceeding with retooling and basing a floor program on the Rotodyne and asked if it was true that noise had been an important factor in BEA's refusal to order the VTOL transport.
- **Treatment of Handley Page** in selection of the Avro 748 over the Dart Herald for Royal Air Force use was a "disgraceful situation" (AW Feb. 19, p. 36) and that the Royal Air Force was "hopping mad" over the decision.

Lee claimed: "We feel the government's record in the aircraft industry is typical of the sloppy, shipshod way in which they have bungled so many of the economic problems which now face the country."

In discussion of the much disputed decision to drop the Rotodyne, Arthur Skeffington, a Labor spokesman, contended:

"It could be . . . that the Rotodyne is the victim of the new licensing system, because BEA feels that it cannot be made the hostage to fortune if it does not know what licenses are to be granted in two or three years' time. This is a new factor of uncertainty which the corporations did not have to face a few years ago. . . .

"I hope that none of us will live to see, should this machine be flying in a year or two, that it has been taken over by the Americans, which is what, I fear, may happen."

Supporting Thorneycroft in the debate, Sir Arthur Vere Harvey spearheaded an attack on U. S. sales methods in Europe, noting:

"The real critics are the Americans, who attack the industry in this country and will go to any length to denigrate British aircraft."

Harvey claimed that Lockheed Air

Fairchild Reports Profit

Fairchild Stratos Corp., Hagerstown, Md., completing its first year under new management, reported a net profit of $3,129,038 for 1961 on sales of $75,959,862 compared with a 1960 loss of $5,994,650 on $85,096,896 sales.

President Edward G. Uhl attributed the loss-to-profit change to significant operating cost reductions.

craft a year ago extended an invitation to members of Parliament to go to the United States with their wives, free of cost, to see what was going on, saying "I mention it merely to show the extent to which the Americans will go to influence foreign parliaments." He said about eight or 10 members accepted the invitation.

In a reference to Rolls-Royce, Harvey mentioned the indirect competition to supply the Anglo-French supersonic transport with a Bristol Siddeley Olympus or Rolls-Royce engine, demanding "I want to know where Rolls stands in this matter."

Said Harvey: "The firm has millions of shareholders' money locked up in research and development. Unless this great company, employing nearly 40,000, is given some real research work, its position will become very precarious in a year or two."

Behind the scenes in all these negotiations between the politicians here and in France, we have the Americans at work. There is the pressure of Pratt & Whitney who would like to keep Rolls Royce out of Europe at any price."

Harvey said progress on the Short Belfast turboprop transport for RAF was good, but questioned whether it is economic for a company to be making only 10 of a new type. He said it probably will be the most expensive aircraft ever produced in Britain, putting the cost at up to $150 million.

British Treasury's Export Credits Guarantee Department (AW Mar. 19, p. 53), was criticized by Philip Hocking, a Labor member, as having only a three year life and urged the government to at least match the 10-year terms offered by the Americans. Present British practice is a five year maximum.

Labor's "shadow defense minister," George Wigg described Thorneycroft as one of the most polished and furnished politicians in the House but said that "When in a difficult position, and the ice is thin, he keeps running and even covers the water, after the ice has melted at such a speed that he gets to the other side."

In Wiggs' view, the immediate job for the ministry is cancellation of the Belfast, the Scasling missile and a fresh look at the Blackburn NA 39 Buccaneer.

In a discussion of estimates, Labor Member John Cronin cited these missile costs before accusing the government of wasting $600 million.

- **Blue Streak**—$250 million so far.
- **Sea Slug**—$200 million for a weapon designed to combat aircraft that soon will cease to exist—planes that bomb ships directly or at short range.
- **Thunderbird**—$120 million, and it largely duplicates Bloodhound. Latter cost has remained classified.
- **Firestreak**—$60 million.
- **Blue Steel**—Nearly $200 million.

Cronin also cited as forerunners of the Rotodyne the following military projects which were canceled when the government withdrew support: Hawker 1083 supersonic fighter (1953), Vickers Supermarine 545 (1955), Avro 720 (1956), Saunders-Roe 177 (1957), and the Hawker P 1121 Canberra replacement (1958). He added that the English Electric Lightning thus is Britain's only supersonic fighter and "it is a very poor show among the masses of supersonic aircraft which the Russians showed at Tushino and the French at Le Bourget."

Replying for the government, C. M. Woodhouse, parliamentary secretary to the ministry of aviation, said of opposition allegations:

- **Reason why the Rotodyne was canceled was that neither BEA nor the RAF was prepared to order it, BEA on the grounds of its economics. Strong objections to the Rotodyne were raised by the London County Council, on the grounds of noise. Effect on Westland employment will be negligible.**
- **There are certain snags connected with the fuze of the Vickers Vigilant that have nothing to do with the ministry. These will be cleared up shortly and it will be possible to get down to a firm order.**
- **On balance, the Avro 748 and the Dart Herald were about even and considering all implications, differences in costs between the two would not be very much. Thus the policy to order from the groups prevailed in this particular case.**
- **Ministry of Aviation places contracts for research and development with the industry to the extent of about six times the value of contracts carried within the Royal Aircraft Establishments.**
- **About 6% of aircraft production teams are design staff and indications are that there will be a decline in employment, with decisions taken by the companies in the light of information available on the extent of government orders and requirements. In the past two years, the industry has shed about 2½ million sq. ft. of space out of 30 million and a half million will come back into the industry when Beagle takes over the de Havilland plant located at Christchurch (AW Mar. 12, p. 265).**
- **In the immediate present, the principal groups have orders for between 80 and 90 transport aircraft in the home civil market, for nearly 100 in the export market and for nearly 100 to the Royal Air Force. He included the sale of Vickers Viscounts to Red China, adding "The contract is firm and will be honored."**

Opposition motion criticizing ministry handling of industry problems was voted down 260 to 201.

WHO'S WHERE

(Continued from page 23)

Honors and Elections

Arthur A. Collins, president of Collins Radio Co., has received the U. S. Navy's Distinguished Public Service Award, in recognition of the national significance of his contributions to naval communications and in appreciation of his continuing efforts in behalf of the United States.

E. O. Cocke, senior vice president industry affairs for Trans World Airlines, has been elected president of the Wings Club, New York, N. Y.

J. W. Kinnucan, vice president of Continental Motors Corp., has been elected 1962 chairman of the Propulsion Technical Committee of the Aerospace Industries Assn.

Changes

Dr. Wilford E. Morris, chief research engineer, Scintilla Division, The Bendix Corp., Sidney, N. Y.

Robert W. Falconer, manager of Aerospace Corp.'s Pacific Missile Range Office, Vandenberg AFB, Calif.

Lyle R. Grosberg, chief engineer, Government Products Engineering, Lenkurt Electric Co., Inc., San Carlos, Calif.

Dr. Irving J. Cabelman, director of advanced studies, Rome Air Development Center, Griffis AFB, N. Y.

Grant D. Christensen, manager of engineering services, McDonnell Aircraft Corp., St. Louis, Mo., and **William T. Summerlin**, manager of engineering reliability.

Donald W. Moore, manager, Magnetics Division, Microdot, Inc., South Pasadena, Calif.

Abraham Berg, manufacturing manager, Aerotest Laboratories, Inc., Deer Park, N. Y.

Warren J. Merboth, customer relations manager, Astropower, Inc., of Costa Mesa, Calif.

Oreland A. Thorsjo, director, Apollo Program, Aeronautical Division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. Other Apollo assignments: **Lincoln Hudson**, engineering manager; **Peter P. Lundquist**, systems project engineer; **Alex B. Chudyk**, operations manager.

George W. Lober, marketing manager, Sperry Gyroscope Co.'s Field Engineering Division, Great Neck, N. Y.

George Denhofer, manager, sales and service, Electronics Division, Piper Aircraft Corp., Lock Haven, Pa.

John E. Thomas, manager, systems and procedures, Allegheny Airlines, and **Robert F. Roland**, manager-computer methods.

A. J. Cannon, district manager of Leach Corp.'s newly established Boston, Mass., district office.

Ryan Aeronautical Co. has announced the following assignments: **E. R. Christopherson**, manager of southeast marketing, Huntsville, Ala.; **C. E. Peterson**, Washington (D. C.) marketing representative; **R. L. Gibson**, Washington (D. C.) representative for Ryan Electronics.

Jerome P. Mullin, product line manager for space simulation devices, ACF Electronics, a division of ACF Industries, Inc., Riverdale, Md.

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If you're one of those rare individuals who can cope with today's engineering frustrations *without losing sight of your long-term goals,* Light Military's emphasis on professional development for *experienced engineers* should be of great personal interest to you.

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- Microwave Design Techniques
- Logical Design of Digital Computers
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- Advanced Mathematics
- Servomechanisms
- Switching Circuits
- Transistor Theory
- Manufacturing Processes
- Heat Transfer
- Advanced Electromechanical Technology Lecture Series
- Magnetics
- Computer Programming
- IR Systems

SPECIAL COURSES

These are developed in response to the needs of our technical personnel or changes in the business complexion. For example, we are currently offering an ENGINEERING PROJECT MANAGEMENT COURSE which is designed to prepare the experienced engineer in the administrative and technical control functions necessary in any engineering project.

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In this program, course work and lectures are conducted by regular members of a professional university staff and are selected from the total range of graduate courses in electrical and mechanical engineering, physics, and mathematics. University counselors are also available to guide our engineers in academic matters and aid them in selecting the advanced degree program that best fits their needs.

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Until recently, the thrust which propelled rocket vehicles into their coast stage, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

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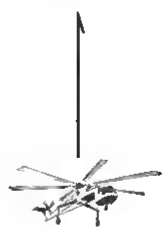

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Reply in complete confidence by phone, wire or letter to:

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- **SYSTEMS TEST**
- **OPERATIONAL EVALUATION**

The Applied Physics Laboratory is responsible for the operational evaluation of the Polaris submarine and missile system. APL also has full responsibility for the Navy's Terrier, Tartar, Talos and Typhon guided missiles from conception through design development, and shipboard test and evaluation.

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Send your resume to:
Professional Staff
Appointments

The Applied Physics Laboratory
The Johns Hopkins University

8687 Georgia Avenue,
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Engineers, Scientists

what's your opinion:

1

ON HOW TO STORE AND PRESSURIZE CRYOGENIC PROPELLANTS IN SPACE, MAINTAINING INSTANT READINESS?

At Bell Aerosystems, Design Engineers are carrying on a concentrated attack on this problem as it relates to space propulsion rocket engines, where weight and reliability are at a premium. This is an expanding activity at Bell. Your professional contributions will be welcomed if your experience and background equips you to analyze steady-state and transient heat transfer effects interrelated with thermodynamics and chemical kinetics of pressurization under varying space environments.

2

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Advanced Engineering degree plus minimum 3 years experience in internal aerodynamics and propulsion system analysis—to head a group engaged in performance analysis of turbojet and ramjet engines and installations.

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Please address resumes to Mr. George Klock

BELL AEROSYSTEMS CO.
DIVISION OF BELL AEROSPACE CORPORATION—A textron COMPANY
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(Classified Advertising)

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50-99	29.20 EA	4.50 EA
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Prices are F.O.B. Cleveland, Ohio. Supplies are limited and offer will definitely not be repeated.

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ADVERTISERS IN THIS ISSUE

AVIATION WEEK, APRIL 9, 1962

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr

ADVERTISERS INDEX

LETTERS

B-70 Action

Every year about this time the B-70 program is in the news with Congress authorizing additional funds, and the Defense Department declining to use them. This time, however, it appears that Congress may exert considerable pressure on the Executive branch to use the funds or to show cause.

As a taxpayer, I am vitally interested in government expenditures while appreciating the massive cost of our national security. The B-70 represents a more expensive manned weapon system than has ever been conceived before. When compared to the cost of our space ventures yet to come, it may prove to be minimal. I believe that the decision currently before the government on this program will affect our national security for years to come. Reliance on missiles and outdated highly overstressed B-52s for the next decade seems foolhardy if we believe the evidence from the Mercury program. Rapid delivery of less than catastrophic weapons by a manned atmospheric vehicle with decision-making capability seems absolutely essential to survival.

If the B-70 is outdated what have we to replace it which will provide comparable ability within the lead-time left before the B-52s are phased out?

It should be obvious to all who read AVIATION WEEK and their daily newspaper that numerous investigations have been made of the B-70 program, why, then, this continuing hassle? Either it is worth top priority, or it should immediately be curtailed. Where national security is at stake, there is no room for political maneuvering or personality conflicts.

RICHARD A. WORDEN
Torrance, Calif.

Weekend Travelers

The air carriers talk of diverting traffic from other forms of transportation, in particular the family automobile, when they should think more about the possibilities of developing new markets from non-travelers: more air-coach and low-rate shuttle service could bring out the weekender who cannot afford the money to fly first class for a two-day weekend to, say, New York from Columbus, Indianapolis, Louisville, Cincinnati, but who could not consider such a trip by any means but air.

Airline executives are so obsessed with the problems of aircraft utilization and declining load factors that they even discourage the weekend traveler. From Columbus to New York, for example, so little coach service is available Friday afternoon that a trip must be planned weeks in advance. As a result, a modestly salaried junior executive just forgets about spending several normal two-day weekends in New York each year. Driving that distance would be out of the question even if gasoline cost three cents a gallon—there would be so little time left in the big city. When he takes his two-week vacation he drives—perhaps to some out-of-the-way camping site. He has not developed the habit of flying.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The carriers may not want weekend business as such. They may see no point in providing coach service to smaller towns or extra sections on weekends to any but the largest cities, as they would probably lose money on that kind of business. But if the airlines want to develop new markets, they should risk losing here and there in order to get more people to fly. Eventually it could pay off in longer trips taken during the week, as more Americans developed the flying habit.

WALTER J. MILLER
Columbus, Ohio

Space Objects

I have seen nothing published in explanation of the friendly little objects ("What did they say, John?") that Col. Glenn observed at his three orbital dawns.

I wish, in the absence of such explanation to offer one of my own.

First there are certain facts that we know. The objects reflect sunlight and are seen against the dark sky during the unusual dawn lighting conditions. Apparently they are small particles of something. They drifted by the capsule at three to five miles an hour. In other words, they are in orbit traveling at approximately 17,500 mi. an hour. Any object in orbit at Col. Glenn's altitude, traveling in exactly the same orbit as Col. Glenn, would travel at exactly the same speed. To drift by the capsule at three to five miles per hour, the particles must be in almost exactly the same orbit as Col. Glenn.

The particles apparently were not residue from Col. Glenn's altitude control jets. He tried using the jets and did not notice any fresh supply of particles. They might have been residue from the capsule-booster separation maneuver. This is unlikely. Col. Glenn lost sight of the booster early in the first orbit. The residue from the booster separation would probably disperse with the same order of rapidity. In any event I would expect the pattern of residue to be considerably different at each orbit. What Col. Glenn saw was the same at each dawn.

I think the particles were pre-meteoric particles. I have read that 90 million visible meteors enter the earth's atmosphere each day and that the vast majority, before they burn up, are tiny particles of gas at near absolute zero temperature. If 90 million hit the atmosphere many times more must be near misses. Of these hundreds upon hundreds of millions must take up parking orbits about the earth. These pre-meteoric orbital particles must be circling the earth in every conceivable orbital path at every conceivable altitude and degree of eccentricity which does not dip them into the atmosphere. The ones in other orbits than Col. Glenn's he wouldn't see as their relative speed would be too great. In these parking orbits the particles must remain until collisions with each other and atmosphere particles bring them down as meteors or as dispersed gas.

This explanation so appeals to me that I wonder why the Glenn Effect was not predicted and looked for. Maybe because the professional cosmologists among your readers will shoot my theory full of friendly holes.

JOHN M. KENNEDY, P.E.
Brooklyn, N.Y.

Eye-Level Display

The pilot's eye-level display mockup, depicted on p. 109 of the Jan. 29 issue of AVIATION WEEK and SPACE TECHNOLOGY, was extremely interesting but incomplete. Several important aspects of this system may be of interest to your readers. This "heads up" eye-level presentation was developed by Rank Cintel, Ltd., and the RAE, Farnborough, England. The system, adaptable to nearly all civilian or military cockpit configurations, is available in the United States through Itek Laboratories, Palo Alto, Calif.

Lightweight and compact, the system will accommodate basic flight information, as well as flight direction for navigation or for particular maneuvers or events. It is ideally suited for presenting to the pilot all necessary normal flight information for takeoff, maneuvering and landing. The collimated symbols are displayed on an optically flat glass transparent screen directly in front of the pilot. The symbols appear green, and the intensity is varied to maintain any desired contrast level. If orange symbols are desired, a special filter may be inserted.

Although the flight information display system was designed for normal flight conditions, it can be of tremendous aid in abnormal weather conditions or in congested flight patterns.

A. R. BENFORD
Project Manager
Itek Laboratories
Palo Alto, Calif.

Weighted Figure

I am wondering how many letters you will receive about the statement on p. 20 of your Mar. 5 issue, "MA-6 capsule with the escape tower weighed 4,265 lb. at launch. At apogee in the orbital configuration, it weighed 2,987 lb. . . ."

At apogee the capsule's mass may have been 2,987 lb., but its weight was nothing—thus stems all this jazz about weightlessness.

P. M. KLAUBER
Chief Administrative Engineer
Solar Aircraft Co.
San Diego, Calif.

(Reader Klauber has a point. In orbit, the mass of the MA-6 capsule was the same as it was on earth: 2,987 lb. referred to the physical system in which the pound is a unit of mass. Apparent weight of the MA-6 capsule in orbit was zero—Ed.)

n January 12, 1959 the National Aeronautics and Space Administration A) selected McDonnell Aircraft Corporation for the design and construction anned spacecraft to be launched by an Atlas booster, placed in a controlled around the earth and returned, safely. This project was called Mercury. welve months and 3 days later the first spacecraft was delivered for flight testing.

On January 31, 1961 a chimpanzee was boosted into space in a Mercury Spacecraft. After a 418 mile flight down range, the spacecraft and Astro-Chimp, Ham, splashed into the Atlantic and were recovered safely.

Two years, three months and 23 days after the contract was announced, Astronaut Alan Shepard climbed into a Mercury Spacecraft for a down range flight witnessed by the world. Eleven weeks later, Astronaut Gus Grissom duplicated the feat.

On November 29, 1961, another high flying Chimpanzee, named Enos, rode twice around the earth and was successfully recovered.

. . . the Evolution of a Spacecraft

Three years and 39 days after the project began, a Mercury Spacecraft carrying Astronaut John Glenn was launched by an Atlas booster and placed in a controlled orbit. After three orbits, spacecraft and astronaut returned safely to the Earth and were recovered. It is significant to note that the initial assignment has been completed. The Mercury Spacecraft is now operational, a literal laboratory for astronauts as they continue the study of man's capabilities in space. McDonnell is now designing and building a two-man spacecraft for NASA. Called Gemini, it will be capable of long term orbital missions and rendezvous with another space vehicle while in orbit. Chapter 1, Book 1 of a great new American enterprise has now been written. Chapter 2 is just beginning.

MCDONNELL

Employment opportunities exist on projects in the national interest such as Mercury, Gemini and Asset Spacecraft; F4H, F-110A and RF-110 aircraft.
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